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# THE ESSENTIAL NEED OF FUNDAMENTAL RESEARCH FOR SOCIAL PROGRESS[1]

By DR. ALAN GREGG
THE ROCKEFELLER FOUNDATION

IF there be some measure of truth in the observation that children seek the unknown but adults fear it, then research is a kind of fountain of eternal youth, for research, whose purpose is to meet the unknown, provides our minds with the perennial freshness and delighted curiosity of youth. In meeting here to-day to honor the National Research Council we are happy to celebrate an institution that has brought knowledge to youth and youth to knowledge. We seek to honor the National Research Council for its work, begun in 1916 and still continuing, in the furtherance of research work in the United States of America.

Yet praise is not what research needs: it needs better understanding. Unless the nature and value of research is more widely and more intelligently understood it will not flourish in our democracy. Research requires discrimination of a high order and tenaciously loyal support. Research does not employ magic: it calls for observation, experiment and reasoning. It is not hidden: few human activities are so accurately recorded or so freely communicated. It is not mystical: it rests upon experience and clear thinking. It is not the plaything of scholars: it is the laborious, costly, incessant, painstaking occupation, and preoccupation, of imaginative men and women who are humbly but actively dissatisfied with even the most that is yet known about men and things.

Unless we are prepared in the immediate future to initiate, pursue and support all kinds of research,

[1] Address delivered on the occasion of the presentation of the American Pharmaceutical Manufacturers Association award to the National Research Council, December 11, 1944 (Hotel Waldorf-Astoria, New York City).

and as never before, the New World will not remain on this side of the Atlantic or the Pacific. Any nation, any business, any university can ignore the importance of research but only at the inevitable price of losing its strength and foregoing its youth. Knowledge is power; and new knowledge is fresh power. How can we afford merely to wonder at the benefits research has already and certainly brought—and leave it at that?

My title is "The Essential Need of Fundamental Research for Social Progress." Such a title implies at least three questions worth answering: Is research essential for social progress? Is it fundamental or superficial research that is essential? What is the essential need of fundamental research?

Permit me a few comments on the first question: Is research essential for social progress? The question tempts me to a blunt remark: Is running essential when you are in a stampede? In other words, with research as a tool available to your competitors can you ignore its power? If you doubt the power of research look about you: Who here is dressed in homespun? Who here breakfasted exclusively on unprocessed foods raised and transported without benefit of meteorology, chemistry, physics and biology? Who got here on his own feet without the aid of airplane, train, subway, taxicab or elevator? Can you, or any one else, stop by fiat or pious resolve the advances of technology? Not without getting left so far behind as to make the words "social progress" a cackling mockery. I suspect that there have been societies and states in the history of the world in which life and human relationships were to the healthy participants as agreeable or more agreeable than life in these modern times is to us. But I am quite sure you wouldn't trade your life for theirs: you like to get well from a ruptured appendix, diphtheria or an acute mania or a rodent ulcer of the face—they couldn't and they didn't. In fact, it is precisely in the field of medical science that I would insist that progress is real. Do you seriously expect progress in the field of drug therapy to come from ignoring the kind of study which has given us our present amazing results in the use of insulin, liver extracts, vitamins, the sulfa compounds and penicillin?

"Social progress?" Let me tell you a story. One night in Berlin about 1929 I met Fritz Haber, whose fundamental researches on fixing nitrogen had enabled the Germans to fight the last war with synthetic explosives, independent of saltpeter from Chile. Despite this service to his Fatherland Haber was later rewarded by the Nazis with persecution and a broken heart. That evening he asked me if I found the research institutes of the Kaiser Wilhelm Gesellschaft at Berlin-Dahlem an ornament to German culture. I said "Yes." He replied: "Excuse me, it is not quite so! Ornament, no! Necessity, yes! We have enough solar energy in Germany to raise food enough to feed 38,000,000. From technological superiority alone can we export manufactures enough to buy the food for the other 20,000,000. From research only comes technological superiority. From brains depend twenty million people. It is not an ornament—it is a necessity."

It was fundamental research that Haber was talking about. Research comes from curiosity and fundamental research comes from curiosity about fundamentals. If we pose the question, "Is the kind of research which is essential to social progress *fundamental* research or *superficial* research?" the answer comes so promptly that I would apologize were it not for just one fact: fundamental research sometimes seems so far away from the immediate need that most laymen often distrust and in times of financial difficulties usually desert fundamental research. Indeed all the discoveries that have been described to you this afternoon began in logical curiosities regarding fundamentals and in their earlier stages were far removed from their eventual applications. They were not hastily improvised answers to impatient questions. They were discoveries of facts so deeply fundamental that as new facts they suggested still newer questions to which they were obviously the answer. In many a case the possible utility of a newly discovered fact becomes apparent *after* the discovery; indeed, the exquisite imagination of Fleming, who first suspected the existence of penicillin, lay just in realizing what his observation might be the answer to. Fundamental research answers questions we sometimes don't know enough to ask. Of course I do not wish to imply that fundamental research is not planned, deliberate, orderly and at times austere. It is all those things and withal it is free—free of the niggardly necessity to be bound to trivial needs or the petty tyrannies of the mind. The physics, chemistry, mathematics and psychology of to-day become the physiology and sociology of to-morrow and the therapy and social progress of the day after. We ought to know that. And yet I can not find a single department of pharmacology in the medical schools of North America adequately staffed and equipped in point of organic chemists, biophysicists, pharmacologists and clinicians.

This disturbing situation leads me to the last question I have raised—What is the *essential* need of fundamental research in the medical sciences? The answer is brains and character—research men well chosen, well trained and well supplied with freedom and facilities to work on fundamental questions. In so far as money serves the purpose of finding, training and cherishing exceedingly competent investigators it is

money invested, not money spent. Precisely because the National Research Council has sought through its fellowships to find and train investigators and teachers, and through its research programs sought to give research opportunities to competent workers we are here to-day to thank its members and offer the tribute of admiration and respect. The most essential need of fundamental research in medical sciences is men—men of attainment and men of promise still to be fulfilled. They can't live without salaries, they can't work without laboratories, they can't teach without pupils who want to join the ranks. Their curiosities are not to see how much they can take from society in money or prestige. They want to understand the fundamental facts of living tissues and living organisms and human relationships. They have their disappointments, their difficulties, their tragedies. They are human. Medical research is an abstraction—the realities are men who search and search again for causes and the relation between phenomena. Until we are prepared in this country to understand the motives, the needs, the rewards, in short the lives of research men we shall go our floundering, hit-or-miss, good-naturedly uncomprehending way, wasteful of these human resources, negligent of our opportunities and happily ignorant of our failures to meet the essential need of fundamental research—the finding, training and support of first-rate scientific brains. One- and two-year grants won't suffice. Medals and citations aren't enough. Time for long study and money for apparatus and helpers and the chance of steady employment—these are what first-rate men need and too rarely get from the society they could shower with the blessings of freedom from pain, relief from disability and the knowledge by which human life is not merely prolonged but rendered happy, freed from fear and ignorance. If you think I exaggerate reflect upon the contributions described this afternoon in the fields of anesthesia, bacteriology, nutrition, physiology and virus diseases.

Created during the first World War, the National Research Council under the auspices of the National Academy of Sciences continued in ensuing years the work of fostering and directing research work in this country. It will resume after this war its work in the service of science and of society. I could hope that in increasing measure the lay public will recognize how valuable are its potentialities, how ready and well qualified it is to administer funds for research work in peacetime and how useful could be its services to society.

Dr. Harrison, you represent the National Research Council not only by your own extraordinary gifts as an investigator, your long services as a counselor and teacher and the example of a splendid character, you also are the designated representative of the National Research Council to receive the tribute offered here to-day to the gifts, the services and the example of the scientists of America in behalf of the public health. I trust that this occasion will aid in a better understanding of the importance of fundamental research in the medical sciences and serve as a warm acknowledgement of the debt of society to the faith which has created and maintained the National Research Council.

# THE STATUS AND PROBLEMS OF RESEARCH IN THE NATIVE LANGUAGES OF SOUTH AMERICA[1]

By Dr. J. ALDEN MASON
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EVEN a relatively short sketch of the linguistic conditions of a large area should cover such points as: general features—phonetic, morphological and lexical—that characterize the languages, and the main points in which they differ from languages of other regions; brief digests of the grammar and phonetics of each independent family or at least of the more important ones; a classification of these families in groups according to phonetic and morphological type; a classification of the component languages of each family in their proper subdivisions as dialects, languages, groups and stocks, according to degree of linguistic relationship; and a reconstruction of linguistic history and migrations. As regards the aboriginal languages of South America it must be understood at the outset that, as comparatively little reliable data are available upon them, none of the above points can be treated with any approach to thoroughness, and on most of them little can be said at present.

South American Indian languages have no uniform or even usual characteristics that differentiate them from North American languages. The same may be said of American languages fundamentally, as opposed to Old World languages. Languages were formerly grouped into categories according to morphological

[1] Vice-presidential address of the incoming chairman of the Section on Anthropology, American Association for the Advancement of Science, Cleveland, September 15, 1944. This address was prepared as the introduction to the linguistic section of the Handbook of South American Indians to be published by the Bureau of American Ethnology of the Smithsonian Institution, and is here printed with the permission of that institution.

pattern: isolating, agglutinating, polysynthetic and inflective, with an implication of evolution and betterment toward the inflecting ideal—of course of our own Indo-European languages. However, research has shown that, so far as there has been any evolution, the isolating is the last, not the first stage. American languages were once classed with the polysynthetic, with agglutinative tendencies. No such hard-and-fast distinctions can be made; few languages belong definitely to one or another class, and most of them show traits of several classes. This applies equally well to American and to Old World languages; some show tendencies towards inflection, more towards polysynthesis. It is impossible to give any description that would characterize the majority of American Indian languages or contrast them with Old World languages, either from a morphological or a phonetic point of view. Incorporation (of the nominal or pronominal object) was formerly considered one of the characteristics of American languages; this also is missing in many of them.

A classification of languages according to patterns and types being impossible, the only possible one is genetic, based on relationship, common origin and linguistic history.[2]

The classification of human groups according to their languages is now accepted as the best system for reconstructing historical connections. Cultural elements are too easily adopted to have much historical value; somatological characteristics, though more permanent than linguistic ones, are less readily identifiable in mixture. On the other hand, a proved relationship of two languages at present widely separated indicates a former close connection or identity of the ancestors of their speakers and thus affords important data on human migration. But proof of linguistic relationship is fraught with innumerable difficulties. It is seldom absolute, but depends on acceptance by scholars; on the other hand, it is impossible to prove that two languages are not related.

Merely to ascertain the connection between two languages is far from sufficient to establish a good historical picture. If we knew no more than that Spanish, Italian, German and Russian are related it would mean little. All the languages of South America may be related; all those of all America may be; conceivably all languages in the world may eventually be proved to have a common descent. In the same sense, all mammals are related, all animals are related, all life had a common origin. Relationship means little unless we know degree and nearness of relationship.

A direct comparison of two distantly related languages seldom yields convincing proof of their connection. A comparison of Polish and English would probably result in a negative decision; it is only because we know the historical linguistics of the Indo-European languages well, with reconstructed roots of words, that the relationship can be proved. On the other hand, no proof would be needed of the relationship of French, Spanish and Italian; even if we did not know their descent from Latin, the resemblance is obvious. The relationship of dialects such as Catalan, Provençal and Gallego is even closer and more evident.

Related languages are grouped in "families" or "stocks," presumed, on present evidence, to be unrelated. These families are then subdivided into divisions, groups, branches, languages, types, dialects, varieties, etc. The terminology is indefinite and there are no established criteria. When families heretofore considered independent are determined to be related, a more inclusive term is required; phylum has been accepted. For instance, if Indo-European, Hamito-Semitic and Finno-Ugrian are "proved" to be related, as has been posited with considerable ground, they would compose a phylum. Most of the eighty-five-odd "families" of North America, formerly considered independent, are now grouped in relatively few phyla.

Good scientific grammars of South American languages are practically non-existent, and grammars of any kind, even of the older type based on analogy with Latin grammar, are very few. Comparisons of morphology, one of the important criteria for linguistic connections, are therefore in most cases impossible. Most of the classifications are based on lexical grounds, on vocabularies, often short, taken by travelers or missionary priests, and generally with the help of interpreters. The recorders were untrained in phonetics and each used the phonetic system of his native language, Spanish, Portuguese, French, German, English, sometimes Dutch or Swedish. Scientific deductions made on the basis of such material have little claim to acceptance. Yet on many languages, extinct or living, nothing else is available. An independent family should not be posited on the basis of one such vocabulary, no matter how apparently different from any other language (*cf.* Masubi).

Of many extinct languages, and even of some living ones, nothing is known; of others there are statements that the natives spoke a language of their own, different from that of their neighbors, but without any suggestion as to how different, or that the language was intelligible or unintelligible or related to that of other groups. Of some, only place and personal

[2] On the classification of languages, and of American Indian languages in particular, see Boas, Introduction to *Handbook of American Indian Languages*, 1911; Harry Hoijer, "Methods in the Classification of American Indian Languages" in "Language, Culture and Personality; Essays in Memory of Edward Sapir," Menasha, 1941, 3–14; J. Alden Mason, "The Native Languages of Middle America" in "The Maya and their Neighbors," New York, 1940, 52–87; C. F. Voegelin, "North American Indian Languages Still Spoken, and their Genetic Relationships" in "Language, Culture and Personality," 15–40; and references and bibliographies therein.

names remain; of others, recorded lexical data ranging from a few words to large vocabularies and grammatical sketches.

Owing to the magnitude of the field it has been possible for me to make very few independent studies and comparisons of lexical and morphological data with a view to establishing linguistic connections, and even most of the articles published by others in support of such relationships have not been critically studied and appraised. The greater number, and by far the most cogent, of these studies have been written by the dean of South American linguists, Dr. Paul Rivet. Similar studies in Macro-Ge languages have been published by Loukotka. In almost all of them the authors were, unfortunately, limited to comparing vocabularies collected by others and pregnant with the faults already herein set forth. Words from lists in one group of languages are compared with words from languages of another group. Rarely are the roots or stems isolated or known, and morphological elements may often be mistaken for parts of stems. Rarely has it been possible to deduce any rules of sound-shift, the best proof of linguistic relationship, or the examples given are too few in proportion to the number of comparisons to carry conviction. Few if any of these proposed linguistic relationships can be said to be incontrovertibly proved; good cases have been made for many, and many or most of them have been accepted by later authorities. Others are of doubtful validity, and all require reappraisal, and reworking, especially those in which new data may later become, or may already have become, available.

It is a truism of linguistic research that, given large enough vocabularies to compare, and making allowances for all possible changes in the form of a word or stem, as well as in its meaning, a large number of apparent similarities, convincing to the uncritical, can be found between any two languages.[3] Especially is this true if the comparison is made between two large groups, each consisting of languages of admitted relationship. To carry conviction, laws of sound-shift must be deduced, obeyed by a large proportion of the cases in question, and a basic similarity in morphological and phonetic pattern must be shown. Few of the comparative works on South American languages attempt such obligations, and almost all suffer from the faults above listed. There is not a real comparative grammar of any South American, or for that matter of any American, native linguistic family, except possibly Algonkian.

One of the pitfalls to be avoided in linguistic comparison is that of borrowing. Languages easily adopt words from neighboring languages; these must be discounted in seeking evidence on genetic relationship. Words for new concepts or new objects are likely to be similar in many languages[4]; generally their categories and very similar forms betray their recent origin. Phonetic pattern and morphological traits are also borrowed, but to a lesser degree. Grammatical pattern is the most stable element in a language, phonology next; vocabulary is most subject to change. There are several areas in America where a number of languages with little or no lexical resemblance have a relatively uniform phonology, and/or similar morphological peculiarities.

Many American languages, North as well as South, show resemblance in the pronominal system, often *n* for the first person, *m* or *p* for second person. Whether this is the result of common origin, chance or borrowing has never been proved, but the resemblance should not be used as evidence of genetic connection between any two languages. Many of the languages of central and eastern Brazil are characterized by words ending in vowels, with the stress accent on the ultimate syllable.

In some cases, the amount of borrowed words and elements may be so great as practically to constitute a mixed language. Linguistic students are in disagreement as to whether a true mixed language with multiple origins is possible. Loukotka, in his 1935 classification,[5] considers a language mixed if the foreign elements exceed one fifth of the forty-five-word standard vocabulary used by him for comparison. Lesser borrowings he terms "intrusions" and "vestiges."

The situation is further complicated by the fact that, in a large number of instances, the same or a very similar name was applied by colonists to several groups of very different linguistic affinities. This may be a descriptive name of European derivation, such as Orejón, "Big Ears"; Patagón, "Big Feet"; Coroado, "Crowned" or "Tonsured"; Barbados, "Bearded"; Lengua, "Tongue." Or it may be an Indian word applied to several different groups in the same way that the Mayan Lacandón of Chiapas are locally

[3] As a few examples, which really should not be mentioned in the same context as Rivet's work, see Miles Poindexter, "The Ayar Incas," 1930, "proving" a connection between Kechua and Sanskrit and other "Aryan languages"; T. S. Dennison, "Mexican Linguistics, including Nauatl or Mexican, in Aryan Phonology," etc., which does the same for Aztec; Julio Salas, "Orígenes americanos; lenguas indias comparadas," Caracas, 1924, wherein connections are seen between all American languages and European ones, based on such analogies as Hecate—Ehecatl, Apollo—Ollin, etc.

[4] See Erland Nordenskiöld, "Deductions Suggested by the Geographical Distribution of Some Post-Columbian Words Used by the Indians of South America," in "Comparative Ethnographical Studies 5," Göteborg, 1922. Also George Herzog, "Culture Change and Language: Shifts in the Pima Vocabulary," in "Language, Culture and Personality," Menasha, 1941, 66–74. Such words as those for banana, cow, telegraph, are pertinent.

[5] Cestmir Loukotka, "Clasificación de las lenguas sudamericanas," Prague, 1935. See also Loukotka, "Linguas indigenas do Brazil," in *Revista do Arquivo Municipal*, LIV, 147–174, Sao Paulo, 1939.

called "Caribs," and the rustic natives of Puerto Rico and Cuba "Gíbaros" and "Goajiros," respectively. Thus, "Tapuya," the Tupi word for "enemy," was applied by them to almost all non-Tupi groups, "Botocudo" to wearers of large lip-plugs, etc. Among other names applied to groups of different languages, sometimes with slight variations, are Apiaca, Arara, Caripuna, Chavante, Guana, Guayana, Canamari, Caraya, Catawishi, Catukina, Cuniba, Jivaro, Macu, Tapiete, not to mention such easily confused names as Tucano, Tacana and Ticuna. Many mistakes have been made due to confusion of such names (*cf.* especially, Arda).

America, and especially South America, is probably the region of greatest linguistic diversity in the world, and of greatest ignorance concerning the native languages. On the very probable presumption that each homogeneous group, tribe, band or village, spoke a recognizable variant dialect or variety, there may have been five thousand such in South America. The index of Rivet (1924) lists some 1,240 such groups (including a few synonyms), and this is far from the total. For instance, in the above index, Rivet lists thirteen component members of the small and unimportant Timote family of Venezuela; in his monograph on the Timote[6] he mentions 128 names for local groups, apart from the names of the villages occupied by them.

The multitude of languages in America has often been given as an argument for a comparatively great length of time of human occupation of this hemisphere. This concept presupposes that the first immigrants to America had a common speech. This is unlikely; it is more probable that each migrating group had its specific language, and that the number of presumably independent linguistic families was originally much greater than at present. Such a reduction has been the linguistic history of the rest of the world. These "families" may either have had a remote common ancestry or multiple unrelated origins; of the origin and early forms of speech we know nothing. All known "primitive" languages are highly complex and evidently have had a long period of development. Of course the minor dialects and obviously related languages were differentiated in America.

Since the main migration to America is believed to have been via Alaska, we would expect to find in South America languages of older migrations than in North America, the speech of the earliest migrants forced to the peripheries and to cul-de-sacs by later and more aggressive groups, and also small enclaves of moribund independent linguistic families. This applies especially to southernmost and easternmost South America, and to the speech of natives of paleoamerican physical type, such as the Ge and the Fuegians.

Regarding extra-continental relationships, many ill-conceived attempts have been made to show connections between South American native languages and Indo-European or Semitic ones; all these are so amateurish that they have been accorded no scientific attention. Dr. Paul Rivet is firmly convinced of the connection between Australian languages and Chon, and between Malayo-Polynesian and Hokan. Instead of by direct trans-Pacific voyages, he believes that the Australian influence came via the Antarctic during a favorable post-glacial period not less than 6,000 years ago.[6a] This radical thesis has met with no acceptance among North American anthropologists. The data offered in its support fall short of conviction, but probably have not received sufficient careful consideration.

It is possible that some of the South American languages belong to the great Hokan or Hokan-Siouan family or phylum of North America. (*Cf.* Yurumangui, Kechua.) Since isolated Hokan enclaves are found as far south as Nicaragua, evidence of migrations across Panama would not be entirely unexpected. A number of languages from Colombia to the Gran Chaco have Hokan-like morphological patterns. Dr. J. P. Harrington is convinced of the Hokan affiliations of Kechua, but his published article[7] fails to carry conviction, and no other argument for Hokan in South America has been presented. Such Hokan migrations, if proved, were probably at a relatively early period.

On the other hand, several of the great South American families have penetrated the southern peripheries of North America. Chibchan languages occupied a solid area, with possibly a few small enclaves of other families or isolated languages, as far as the Nicaraguan border, and the probably affiliated "Mosumalpan" (Miskito-Sumo-Matagalpa) would extend this area to cover Nicaragua. Arawak and Carib extended over the Lesser and Greater Antilles, and the former may have had a colony on the Florida coast.

In 1797 the native Carib Indians remaining in the Lesser Antilles, mainly on St. Vincent Island, were transported to Roatan Island off the coast of Honduras. Mixing with the Negro population there they have spread over much of the coast of Honduras and parts of British Honduras. They now number some 15,000, most of them speaking a Carib jargon.

The trend in the classification of American languages has been quite opposite in North and in South

[6] Paul Rivet, La Famille linguistique Timote. International Journal of American Linguistics, 4, 137–167, New York, 1927.

[6a] Paul Rivet, "Les melanéso-polynésiens et les australiens en Amérique," in *Anthropos*, XX, 51, 1925, and many other articles. (See bibliography in Pericot, p. 432.)

[7] John P. Harrington, "Hokan Discovered in South America," *Journal of the Washington Academy of Sciences*, 33: 11, 334–344, Washington, 1943.

America. In the former, radical scholars believe that all the many languages formerly considered independent may fall into six great phyla: Eskimo, Na-Dene, Algonkian-Mosan, Hokan-Siouan, Macro-Penutian and Macro-Otomanguean, plus the South American phylum Macro-Chibchan. In South America, on the contrary, the more recent classifications have increased rather than reduced the number of families or groups given independent status. Most of these new ones, it must be admitted, are one-language families, often extinct, and generally based on one or a few short vocabularies that show little or no resemblance to any other language with which they have been compared. These should be considered as unclassified rather than as independent families. It is certain that the number will be greatly reduced as the languages become more intensively studied, but doubtful if it will ever reach such relative simplicity as in North America. Almost certainly the linguistic picture will be found to be far more complex than in Europe and Asia.

One of the main reasons for the great difference in the proposed number of linguistic families in North and South America is that the study of South American linguistics is now about in the same stage as that of North American languages thirty years ago. Since that time many trained students, both in the United States and in Mexico, have studied the native languages intensively, largely under the direction or example of the late Drs. Franz Boas[8] and Edward Sapir. Except for the indefatigable Dr. Paul Rivet and Curt Nimuendajú, South America has had few linguistic scholars of wide interests and scientific viewpoint, and until recently very few trained younger men. The North American languages have been grouped into six phyla, mainly on grounds of morphological resemblance and intuition, and in this the students have been aided by the fact that the languages are fewer, and fewer of them extinct, so that such morphological studies could be made. South America suffers not only from lack of students, paucity of grammatical studies, multitudes of languages, extinction of many of them, but also from the practical problems of linguistic research: immense distances, poor transportation, difficulties and expense of expeditions, lack of capable interpreters and similar handicaps.

The history of attempts to classify the languages of South America was reviewed by Chamberlain in 1906.[9] The earlier classifications, such as those of Adelung and Vater, Balbi, Castelnau, Gilij, Hervas, Ludewig, von Martius and d'Orbigny, were not considered therein, and need not be here. Modern classification began with Brinton in 1891.[10] With his usual far-seeing good sense, not "curiously enough" as Chamberlain remarks, Brinton refused to enumerate or list his "stocks," but apparently recognized nearly sixty. In many later short articles Brinton continued to alter his groupings. Other lists published in the next few years were McGee, 1903 (56); Chamberlain, 1904 (57); Ehrenreich, 1905 (52). All these differ more than the slight variation in total would suggest. Chamberlain then gave his own list, totalling 83. Later he published a revision of this, which became the standard classification in English for a decade or more.[11] Though the total of 83 stocks is exactly the same as in his earlier list (plus 77a), the number of alterations, deletions and additions is great.

Since 1922 a number of classifications have appeared. Krickeberg[12] stressed only the fifteen most important families; based on this Jiménez Moreno published a large distribution map in color.[13] P. W. Schmidt also wisely did not attempt to enumerate and list every family, but discussed them under 36 families or groups.[14] Curt Nimuendajú has never attempted a complete linguistic classification of South America, and his unpublished map and index do not include the far north, west and south, but his first-hand knowledge of the rest of the continent is unexcelled. In this restricted region he recognizes 42 stocks, 34 isolated languages and hundreds of unclassified languages, the latter generally without any known linguistic data.

Two comprehensive classifications of all South American languages have been made in the last twenty years. Paul Rivet,[15] combining some of Chamberlain's families, separating others, reached a total of 77. Pericot[16] follows Rivet very closely, but not in

[8] See especially "Handbook of American Indian Languages," edited by Franz Boas, Parts 1 and 2, Bulletin 40, Bureau of American Ethnology, Washington, 1911, 1922; Part 3, New York, 1933.

[9] Alexander F. Chamberlain, "South American Linguistic Stocks" in C. R. Congr. Internat. d. Amer., XV$^e$ Sess., Quebec, 1906 (1907), t. II, pp. 187–204.

[10] Daniel G. Brinton, "The American Race," N. Y., 1891.

[11] Alexander G. Chamberlain, "Linguistic Stocks of South American Indians, with Distribution-Map," *Amer. Anth.* (n. s.), 15, 2, 236–247, 1913.

[12] Walter Krickeberg, "Die Völker Südamerikas," pp. 217–423, in Georg Buschan, Illustrierte Völkerkunde, Stuttgart, 1922.

[13] Wigberto Jiménez Moreno, "Mapa Lingüístico de Sudamérica, según Krickeberg; bajo la dirección de Wigberto Jiménez Moreno; lo dibujó Agustín Villagra. Publicación hecha por el Instituto Panamericano de Geografía e Historia, en colaboración con el Museo Nacional y con el Instituto Mexicano de Investigaciones Lingüísticas, en 1937." Mexico, 1936.

[14] W. Schmidt, "Die Sprachfamilien und Sprachenkreise der Erde," Heidelberg, 1926.

[15] Paul Rivet, "Langues Américaines. III. Langues de l'Amérique du Sud et des Antilles," 639–712, in A. Meillet et Marcel Cohen, "Les Langues du Monde," Paris, 1924.

[16] Luis Pericot y García. "América Indígena." Tomo I: "El Hombre Americano—Los Pueblos de América." Barcelona, 1936.

numerical or alphabetical order. The most recent classification and the most radical—or most conservative, according to the point of view—is that of Loukotka.[17] Dividing more of Rivet's families than he combined, he enumerates 94 families with a total of some 558 languages. Later he revised the details somewhat, but only regarding the languages of Brazil. In this latter article he notes the linguistic sources for each language.[18]

South American linguistic history or philology does not extend before the beginnings of the sixteenth century with the first words and observations made by European voyagers. No native alphabets had been developed; there were no hieroglyphs, and even pictographs, petroglyphs and picture-writing seem to be less than in North America. The Peruvian quipus were arithmetical, astrological, divinatory and mnemonic. There was a tradition among the Kechua at the time of the Conquest that they had once had a system of writing on tree leaves that was later forbidden and forgotten,[19] but this is given little credence by modern scholars, and no trace of it remains. A system of writing has been claimed for the Chibcha also, based, not on tradition, but on the peculiar, and apparently non-pictorial character of many pictographs in Colombia; this also has received no credence among archeologists. On the other hand, the modern Cuna of Panama have developed an interesting existent system of mnemonic picture-writing.[20]

Two of the native languages merit special mention as having become, after the Spanish Conquest, *lenguas francas* of wider extent and use than formerly. The Tupi of the Brazilian coast became the basis of the *lingoa geral,* the medium of communication of priests and traders throughout the Amazon drainage; it is now generally replaced by Portuguese. The Cuzco dialect of Kechua became the culture language of the "Inca" region and extended its area even before the Conquest; after the latter it continued its spread and was adopted as a second language by the Spanish in Peru. Neither language has to-day, however, the cultural position of the Maya of Yucatan, for instance, though both have added many native terms in the Spanish and Portuguese of their regions, and even throughout the world, such as *tapioca, jaguar, llama, quinine.* It has been estimated that 15 per cent. of the vocabulary of Brazilian Portuguese is of Tupi origin. In Paraguay, Guarani is considered a culture language, and some newspapers are published in it.

For those exact-minded scientists who may be appalled or disgusted with the classificatory disagreements noted above, let me close with a quotation from a great linguist: "Essayer de faire une classification exacte et complète de toutes les langues en familles rigoureusement définies, c'est montrer déjà qu'on n'a pas compris le principe de la classification généalogique des langues."[21]

[17] Chestmir Loukotka, "Clasificación de las lenguas sudamericanas," Prague, 1935.

[18] Chestmir Loukotka, "Linguas indigenas do Brasil" in *Revista do Arquivo Municipal,* LIV, 147–174, Sao Paulo, 1939.

[19] Montesinos, 1840, 1920, Chaps. 7, 14, 15; Bingham, 1922, Chap. 16; 1929, Chap. 9.

[20] "Comparative Ethnological Studies," 7, Göteborg, 1928, 1930.

[21] A. Meillet, "Les Langues du Monde," Paris, 1924, p. 10.

# OBITUARY

## OSCAR FLOYD POINDEXTER

OSCAR FLOYD POINDEXTER was born on December 8, 1898, at Cynthiana, Kentucky. He was educated in the schools of Cynthiana and the University of Kentucky. On October 4, 1918, he enlisted in the S.A.T.C. of the University of Kentucky and was honorably discharged from the United States Army on December 18, 1918. He then continued his education at the University of Michigan, deserting agriculture, his major at Kentucky, for geology and mineralogy, and received the A.B. degree in geology and mineralogy in 1922 and the master's degree in 1924. During the undergraduate years at the University of Michigan he was a teaching laboratory assistant in the department of mineralogy supervising students in the identification of minerals. In June of 1924, he first entered the service of the State of Michigan in charge of a field party mapping deposits of road-building materials for the State Highway Department under the direction of the Geological Survey Division, Department of Conservation. He was in charge of the field parties during the summers of 1924 and 1925 and in full charge of the road material survey in the summer of 1926. During the scholastic years, 1924 to 1927, Mr. Poindexter was instructor in petrography and general economic and engineering geology in the Case School of Applied Science, Cleveland, Ohio. In June, 1927, he resigned from Case to permanently enter the service of his well-loved adopted State, Michigan, as mineral economist of the Geological Survey Division of the Department of Conservation, and continued as chief of the road materials survey, discovering, testing, mapping hundreds of deposits and writing summary reports of each deposit, as well as working in and writing more detailed reports of the other mineral

industries. The road materials survey ended in 1931 and Mr. Poindexter continued in the department as mineral economist working on mineral resources, especially of the non-metallic minerals, and in general geology. In 1931 he made a personal survey of the mineral resources of Alpena County, of Schoolcraft County in 1932, of the rocks suitable for rock wool for insulation purposes in 1939 and in 1940 he conducted a survey of the limestone areas of the Northern Peninsula potentially important for the production of magnesium. For six months during 1933 he was superintendent of a CCC camp, during which time he devised and carried out the project which made sets of Michigan rocks and minerals distributed to the schools.

Gradually as problems coming to the survey became more numerous, Mr. Poindexter devoted more and more time to the water resources of the state until in 1942 in recognition of his preeminence in the field he was made geologist in charge of water resources investigations, and his time was given almost wholly to the many economic, legal and scientific problems of lake level stabilization, stream flow and flood control and particularly of ground water supplies for individual homes, municipalities and industries. In this field his outstanding achievements were in location of adequate water supplies for war industries, notably for the Willow Run Bomber Plant.

The list of Mr. Poindexter's publications contains sixteen titles, studies in minerals, mineral resources, surface geology in Kentucky and Michigan, and of water supplies, in addition to abstracts of sixty articles on geology and mineralogy which he translated from the French. He was a member of the alumni associations of the Universities of Kentucky and Michigan, of the Michigan Academy of Science in which he was a past chairman of the Geology and Mineralogy Section, and he was a member of the national honorary scientific society Sigma Xi.

He was married on June 4, 1927, to Miss Helen McGurk, of Kentucky, who with two sons, Edward and James, survive him. In his home his life was one of quiet happiness, marked with devotion to and admiration for his wife and intense but calm pride in his sons.

In the field Jake Poindexter was a conscientious worker, considerate, patient, always working for the cub geologists, always anxious they should get ahead; he gave them standards, he was a developer of trained men. His junior geologists, men who were in his field parties and office associates loved and respected him as a bulwark of quiet kindliness, sound judgment yet modest and chary in giving advice. They say of him, "He was an exemplar of the stability and integrity a servant of the state should have." A calm young man but an inspiring teacher.

In the office Jake was always quiet, dependable and efficient, speaking with a soft Kentucky drawl that belied his eager, active mind. He was slow to render an opinion until all sources of information were consulted and all phases of the problem considered and weighed. He never gave snap judgments; he could not be biased. He inspired confidence in the industrialist who sought his advice or sought out his information as well as in the associate working with him and the superior giving him a job to do.

His keen interest in research, his desire to solve some of its geologic problems and so serve the State placed O. F. Poindexter well over the threshold of a promising career in the solution of the pressing problem now confronting Michigan—the conservation of its water supply. By his death, the Geological Survey Division and the whole Department of Conservation have lost a servant whose place can not be filled. His associates have lost the stimulus of a brilliant mind, but, over all, have lost a friend.

HELEN M. MARTIN

## DEATHS AND MEMORIALS

DR. HUGH ALEXANDER BROWN, professor of electrical engineering at the University of Illinois, died on February 25. He was fifty-five years old.

DR. JOHN D. BALL, since 1933 professor of physics and business administration at Mount Mary College, Milwaukee, died on February 10 at the age of sixty-two years.

DR. GEORG BARKAN, assistant professor of biochemistry at Boston University, died on March 7 at the age of fifty-five years.

DR. FRANKLIN C. SNOW, dean of the Georgia School of Technology of Atlanta, died on March 1 at the age of sixty-one years.

THE REVEREND DR. JOHN EDWARD RAUTH, associate professor of psychology at the Catholic University of America, died on March 5 in his fifty-ninth year.

DR. RAYMOND C. SHANNON, Trinidad, entomologist of the Rockefeller Foundation, died on March 7, at the age of fifty years.

HAROLD RYLAND SMALLEY, agronomist and director of soil improvement, emeritus, of the National Fertilizer Association, died on February 27 in his fifty-seventh year.

A MEMORIAL service for Lieutenant Colonel M. F. Morgan, chief agronomist at the Connecticut Agricultural Experiment Station, who was killed in action on Leyte in January, was held at New Haven on March 10.

# SCIENTIFIC EVENTS

## ENDOWMENT OF THE SCHOOL OF CHEMICAL ENGINEERING AT THE UNIVERSITY OF CAMBRIDGE

IN Great Britain, the Shell group of oil companies has offered the University of Cambridge an endowment of £435,000 for the establishment of a School of Chemical Engineering. In addition a sum of £2,500 a year is to be made available for the provision of scholarships. *The Times*, London, writes:

the group attributes a large measure of its own success to the importance which it has consistently attached to scientific and particularly to chemical research and development. It has been impressed through its association with other countries, especially Holland and the United States, by the fact that British universities are relatively ill-equipped to provide this country with the trained chemical engineers which British industry is certain to demand in increasing numbers.

The offer has been made to meet what is clearly a national need and to secure the cooperation of the university where, by the side of great scientific departments, there already exists the largest university school of engineering in the country.

The group has suggested that the best results will be obtained if specialized study of chemical engineering is undertaken after a two-year honors course in the natural sciences. In this view the university authorities concur, and from the academic standpoint attach importance to the fundamental scientific training which an industrial undertaking with a preeminent record of achievement in the domain of chemistry has found, by the light of its own experience, to be essential.

In their plans for the new school the university authorities and the group recognize that the need is for men of the highest quality, and it is proposed that initially the output of qualified graduates shall be about 30 a year, with provision for expansion as university-trained chemical engineers are increasingly absorbed into industry, teaching and research.

## THE JOHN WESLEY HYATT AWARD

ENTRIES for the John Wesley Hyatt Award for achievement in the plastics industry for 1944 have been invited by William T. Cruse, secretary of the award committee.

To be considered, the names must reach the committee's headquarters at 295 Madison Avenue, New York City, not later than noon on March 26.

The award, consisting of a gold medal and a cash gift of $1,000, is sponsored annually by the Hercules Powder Company. It is presented to the individual who, in the opinion of the judges, has made "an outstanding contribution of wide importance to the plastics industry during the preceding year."

Any one may enter or be entered as a candidate for the award. Five points determine eligibility:

*First*, is the achievement practicable, with special reference to availability of materials and production equipment, and to restrictions in fields of application?

*Second*, is the development reasonably permanent and what is the scope for further applications in the plastics industry and similar fields?

*Third*, has the achievement been of import to the plastics industry in the year for which the award is given, regardless of the year of its conception?

*Fourth*, does the development appear to have great promise for the industry in future years?

*Fifth*, the ingenuity required in the development of the achievement.

The award committee consists of Richard F. Bach, dean of education, The Metropolitan Museum of Art; Dr. Lyman J. Briggs, director, National Bureau of Standards; Dr. Karl T. Compton, president, Massachusetts Institute of Technology; Watson Davis, director, Science Service; Dr. Carl S. Marvel, president, the American Chemical Society; George K. Scribner, president, the Society of the Plastics Industry; Dr. Stuart D. Douglas, head of research, the Carbide and Carbon Chemicals Corporation, who received the Hyatt award last year; and the secretary, Mr. Cruse.

Entry blanks are available upon request at the committee's headquarters. These forms provide space for the candidate's name and for complete facts and details regarding his or her particular achievement.

## THE FOURTH ANNUAL SCIENCE TALENT SEARCH

FORTY scholarships for the continuance of engineering and scientific education were awarded on March 6 at Washington to successful contestants of the fourth annual science talent search conducted by Science Clubs of America. The scholarships are provided by the Westinghouse Electric and Manufacturing Company as a contribution to the advancement of science in America. Included in the awards were four-year scholarships of $2,400 to Marion Cecile Joswick, 17, of Brooklyn, N. Y., a graduate of Manual Training High School, and Edward Malcolm Kosower, 16, a Brooklyn, N. Y., resident and a senior at Stuyvesant High School in Manhattan. In addition, one girl and seven boys received four-year $400 Westinghouse science scholarships. Thirty other boys and girls received one-year Westinghouse science scholarships worth $100 each. The sum of $11,000 for these scholarships is awarded each year.

The scholarships can be used to attend any degree-granting college or university, subject to the approval of the scholarship committee of Science Clubs of

America. Scholarships will be held in trust for use after the war for those who enter military service. Forty per cent. of the one hundred and twenty successful contestants are now in military service.

Award of the scholarships was determined at Washington on the basis of individual interviews with the Board of Judges composed of Dr. Harlow Shapley, director of the Harvard Observatory; Dr. Harold A. Edgerton, director of the Occupational Opportunities Service of the Ohio State University, and Dr. Steuart Henderson Britt, chief of the Military Advisory Section of the National Roster of Scientific and Specialized Personnel of the War Manpower Commission.

The fourth talent search opened last autumn when 50,000 high-school principals and science teachers were asked to assist in finding the forty seniors most talented in science in private and denominational schools. Some 15,000 seniors entered. Of these, about 3,000 completed the requirements for being considered for the scholarship awards—a science aptitude examination, the writing of a one-thousand-word essay and submission by the faculty of scholastic and personal records and recommendations.

Speakers at the institute at which the entrants were judged included Major General James C. Magee, U.S.A., retired, former Surgeon General; G. Edward Pendray, secretary of the American Rocket Society; Dr. Roger Adams, Office of Scientific Research and Development, Washington; Dr. Warren B. Mack, president of the American Society for Horticulture and head of the department of horticulture, Pennsylvania State College, and Dr. George W. Corner, department of embryology at Baltimore of the Carnegie Institution of Washington.

## IN HONOR OF PROFESSOR DUGALD C. JACKSON

FRIENDS of Professor Dugald C. Jackson, from 1907 to 1935 head of the electrical engineering department of the Massachusetts Institute of Technology, gathered at the Engineers Club on the evening of February 13 to celebrate the eightieth anniversary of his birth.

After a social half-hour in the library, the company filled the Assembly Hall at the birthday banquet. The speakers included President Compton, who presided; Dean Barker, of Columbia University; President Sah, of the National University of Amoy, China; Dean Moreland, Professor Hazen and Professor C. E. Tucker. Mr. Gerard Swope and Dr. Frank B. Jewett, on the original list of speakers, were not able to attend. President Compton read letters of appreciation from Dr. Jewett and from Dr. Vannevar Bush. President Sah brought greetings from China, and Dean Moreland on behalf of the engineering firm of Jackson and Moreland presented Professor Jackson with a set of the Encyclopaedia Britannica.

Professor Tucker spoke of the one hundred and seventy-four letters of greeting and appreciation that Professor Jackson had received on this occasion from various societies, friends and former students. Before presenting him with a volume of the letters bound in tooled leather, Professor Tucker read typical letters received from the American Academy of Arts and Sciences, the American Society of Mechanical Engineers, Brigadier General Forrest E. Williford, President William E. Wickenden, of the Case School of Applied Science, Professor Ralph G. Hudson, Harold S. Osborne, chief engineer of the American Telephone and Telegraph Company, and the Technology Club of Western Pennsylvania.

# SCIENTIFIC NOTES AND NEWS

THE William H. Nichols Medal of the New York Section of the American Chemical Society was presented to Professor Vincent du Vigneaud, head of the department of biochemistry in the Cornell University Medical College, at a joint meeting on March 9 of the section and the Society of Chemical Industry. The award was made for his work as an "inspiring teacher, gifted scientist, tireless searcher for truth, in recognition of his researches on the structure of biotin and other outstanding contributions to the advancement of biochemistry." Dr. Edwin J. Cohn, professor of physical chemistry in the Harvard Medical School, spoke on "Vincent du Vigneaud—the Man," and Dr. Hans T. Clarke, professor of biochemistry in the College of Physicians and Surgeons of Columbia University, spoke on "The Work of the Medallist." The medal was presented by Dr. Robert Calvert, chairman of the jury of award. Dr. Beverly L. Clarke, chairman of the New York Section, presided. Professor du Vigneaud in his medal address discussed "The Relationship of Structure to Biotin and Antibiotin Activity."

THE 1944 Gold Medal Award of the American Institute of Chemists will be presented on May 11 at the Medal Meeting of the institute to be held in Columbus, Ohio. It will be presented to John W. Thomas, chairman and chief executive of the Firestone Tire and Rubber Company, in special recognition of his "executive ability in translating research results into large-scale production, which was a major aid in the development of America's giant wartime synthetic rubber industry."

THE Minnesota Branch of the American Association of Scientific Workers, in cooperation with the depart-

ment of physiology of the University of Minnesota, gave on February 23 a luncheon in honor of Professor A. J. Carlson, past national president of the association. Dr. Carlson made an address on "Why Should Scientists Organize?" Professor Kirtley F. Mather, of Harvard University, now national president of the association, was honored at a dinner meeting given on February 27 by the Minnesota branch. He spoke on the unique role of the American Association of Scientific Workers in assuring the utilization of science for the public good.

DR. G. W. BEADLE, professor of biology at Stanford University and national lecturer for the Society of the Sigma Xi, lectured on March 3 before the Louisiana State Chapter on "Genes and the Chemistry of the Organism." An informal luncheon at the Faculty Club honoring Professor Beadle was attended by the officers of the chapter, by members especially interested in genetics and by Dr. Fred C. Frey, dean of the university; Dr. Wm. O. Scroggs, dean of the Graduate School, and Dr. H. V. Howe, dean of the College of Arts and Sciences of the State University of Louisiana.

DR. ERNEST CARROLL FAUST, professor of tropical medicine at the Medical School of Tulane University, New Orleans, delivered on February 22 an address entitled "Malaria in the United States—A Historical Perspective" before the Louisiana State Chapter of the Society of the Sigma Xi. Professor Faust was honored by a dinner at the Faculty Club, which was attended by officers of the chapter, members especially interested in parasitology and by the president of the university.

DR. SYDNEY CHAPMAN, F.R.S., chief professor of mathematics at the University of London, has been elected a member of the Athenæum Club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services.

DR. HAROLD D. GREEN, formerly associate professor of physiology at the School of Medicine of Western Reserve University, has become professor of physiology and pharmacology at the Bowman Gray School of Medicine of Wake Forest College, Winston-Salem, N. C. Dr. Robert W. Lackey, professor of physiology, will serve as visiting professor of physiology for the trimester beginning on March 28.

DR. GORDON H. SCOTT, formerly head of the department of anatomy at the School of Medicine of the University of Southern California, has assumed his work as professor and head of the department of anatomy of the College of Medicine of Wayne University.

DR. BION R. EAST, since 1940 assistant professor of public-health practice in the DeLamar Institute of Public Health of Columbia University under the plan of integration of the Faculty of Dentistry with the Faculty of Medicine, has been appointed professor of dentistry and associate dean for dental and oral surgery.

THE third annual meeting of the Oregon Academy of Science was held at Portland on January 13. Officers were elected as follows: *President,* Stanley G. Jewett, Portland; *President-elect,* Thornton T. Munger, Portland; *Secretary,* F. A. Gilfillan, Corvallis; *Treasurer,* R. R. Huestis, Eugene.

THE Society of Economic Paleontologists and Mineralogists has elected the following officers for the year beginning on March 27: *President,* Dr. John R. Sandidge, Magnolia Petroleum Company, San Antonio; *Vice-president,* Dr. J. Brookes Knight, U. S. National Museum; *Secretary-Treasurer,* Dr. H. B. Stenzel, the University of Texas.

THE Potomac Division of the American Phytopathological Society held its second annual meeting on February 20 and 21 at the Bureau of Plant Industry Station, Beltsville, Md. The meetings were well attended, and thirty-four papers were presented. Officers elected for the present year were T. F. Manns, *President;* E. E. Clayton, *Vice-president;* V. F. Tapke, *Secretary-Treasurer,* and R. J. Haskell, *Councilor.*

DR. W. E. LOOMIS, professor of plant physiology at Iowa State College, has been appointed editor-in-chief of the Monograph Series of the American Society of Plant Physiologists. Other members of the board are Professor D. R. Hoagland, of the University of California; Professor J. W. Shive, Rutgers University; Professor F. W. Went, California Institute of Technology; Dr. Gordon Mackinney, University of California, and Professor W. F. Loehwing, University of Iowa.

LIEUTENANT COLONEL JOHN H. BELKNAP, at present on duty with the Army Air Forces in Washington, D. C., has been appointed Yates professor of electrical engineering and chairman of the newly established Division of Engineering of the University of Rochester. He will succeed the late Professor Joseph W. Gavett, Jr.

COLONEL I. S. RAVDIN, who has been since 1936 Harrison professor of surgery and director of the Harrison Department of Surgical Research of the School of Medicine, University of Pennsylvania, and who is now in command of an Army hospital in India while on leave of absence from the university, has been appointed to the John Rhea Barton professorship of surgery in the School of Medicine. Dr. Eldridge L. Eliason, who has held this professorship since 1907,

will postpone his retirement while Colonel Ravdin is on active service.

DR. ARLIE C. TODD, instructor of zoology at the Louisiana State University, has become parasitologist at the Agricultural Experiment Station of the University of Tennessee.

DR. C. B. JOLLIFFE, chief engineer of the RCA Victor Division of the Radio Corporation of America, has been elected vice-president in charge of its laboratories. He will succeed Otto S. Schairer, who has become staff vice-president. Mr. Schairer will be consultant and adviser on matters pertaining to research, development, patents, trademarks and licenses.

DR. ARTHUR N. PRATER has resigned his position with the Western Regional Research Laboratory to become director of research with the C. B. Gentry Company, Los Angeles.

SIR JOHN FORSDYKE, director of the British Museum in London, and Dr. Henry Thomas, keeper of printed books of that institution, recently made a tour of the United States and Canada for consultations with members of the administrative and scientific staff of leading museums in regard to preparation for postwar rehabilitation of museums in Great Britain.

BRIGADIER HUGH CAIRNS, Nuffield professor of surgery at the University of Oxford, and now directing a special neurological service in the British Army, is expected to visit the United States and Canada in April.

THE American Cancer Society will start in April a national campaign to collect five million dollars for a national program for research on the disease. Eric A. Johnson, president of the Chamber of Commerce of the United States, is head of the national executive council, and Dr. C. C. Little is managing director. Members of the scientific committee for the research program are Dr. Little, Professor Charles B. Huggins, of the University of Chicago; Dr. James B. Murphy, head of the cancer division of the Rockefeller Institute for Medical Research; Dr. C. P. Rhoads, director of the Memorial Hospital, New York, and now colonel in the Chemical Warfare Service, and Dr. Florence R. Sabin, of the Rockefeller Institute. Rear Admiral Charles S. Stephenson, who retired recently from the Navy Medical Corps, will be the executive secretary of the research division.

DR. J. BRAUN-BLANQUET, director of the Station Internationale de Géobotanique Méditerranéenne et Alpine at Montpellier, France, reports under date of January 7 that the station had not suffered in spite of the bombings of Montpellier, and that scientific work did not undergo any considerable setback. At present, some students are preparing doctorate theses. The "Communications de la SIGMA" now number eighty-eight. Dr. Braun-Blanquet and Dr. L. Emberger have been commissioned by the "Centre National de la Recherche Scientifique" to prepare a vegetation map of France (1/20,000). Montpellier will serve as headquarters, and the first map is ready for publication.

DR. JOSEPH W. BEARD, associate professor of surgery of the School of Medicine of Duke University, will deliver the twenty-first Ludvig Hektoen Lecture of the Frank Billings Foundation on Friday evening, March 23, at the Palmer House, Chicago. His subject will be "The Ultracentrifugal, Chemical and Electron Micrographic Characters of Purified Animal Viruses."

PROFESSOR ROBERT CHAMBERS, of New York University, gave from February 26 to March 2 a series of lectures and conferences at the Ohio State University, under the auspices of the Graduate School, the Society of the Sigma Xi and the Department of Physiology.

THE annual meeting of the American Society for Clinical Investigation, which was planned for Monday, May 7, in Atlantic City, has been cancelled.

THE activities of the Electronics Department of the General Electric Company under the direction of Dr. W. R. G. Baker, vice-president, will be centered in an industrial development on the outskirts of Syracuse, N. Y., near Liverpool. Activities in electronics are now carried on in several cities. It is expected that construction of the plant on a 150-acre plot will begin as soon as wartime restrictions are lifted. The size of the development will be about a quarter of the area occupied by the Schenectady Works, and it is estimated that the new factory will be ready eighteen months from the time the Government gives permission. The plant will include an administration building, a research laboratory and assembly shops. The movement of employees into the new plant is expected to be gradual. The centralization project will not affect the operations of the radio and television stations in Schenectady.

THE late Oscar M. Stewart, from 1901 to 1944 professor of physics at the University of Missouri, gave to the university the sum of $1,000 to be used, principal and interest, for some educational or scientific purpose connected with the department of physics. This fund may be used for undergraduate or graduate scholarships or fellowships for students in the Department of Physics. In addition to this gift, Professor Stewart set up a trust fund of considerably larger amount to serve the same purposes. Applications for assistance from these funds for the 1945–46 term

should be made at an early date to the chairman of the Department of Physics of the University of Missouri.

SIR HENRY TIZARD, president of Magdalen College, Oxford, formerly head of aircraft research at the Ministry of Aircraft Production, addressed the House of Commons recently at a meeting of the Parliamentary Scientific Committee on problems of aeronautical research with special relation to civil aviation. According to *The Times*, London, "he recommended that aeronautical research should be placed in the hands of an aeronautical research council, which should come directly under the Lord President of the Council, that the director of research at the Air Ministry should be represented on that body, and that the Government should be prepared to spend at least £1,000,000 a year for the purpose." He stated that "the future of transatlantic travel would lie in flying above the 40,000 foot level, and that it could never be a regular and economic service below that height. Flights across the Atlantic should before long be possible in automatically controlled machines which would not need any navigator on board."

# DISCUSSION

## BLANCAN AS A TIME TERM IN THE CENTRAL GREAT PLAINS[1]

THERE are extensive Cenozoic deposits of nonmarine and nonglacial clastic sediments in the Central Great Plains region of the western interior of the United States. These deposits, mostly unconsolidated, underlie the surface of this plains area to depths of more than 500 feet, and they are considered to be mostly of upper Tertiary (Pliocene)[2] and Quaternary (Pleistocene) age. During recent years their character, stratigraphy, faunas, floras and correlations have been studied in some detail. For the most part the term Ogallala formation (or group) has been applied to that part of these deposits agreed to be Pliocene in age, and a multiplicity of names has been applied to the clastic sediments agreed to be Pleistocene in age.

The placing of these strata within the standard scale of geologic time has been accomplished largely by a study of their contained faunas supplemented by paleobotanical and stratigraphic studies. These faunas, consisting mostly of fossil vertebrates, have generally proved satisfactory for the correlation of beds within the Great Plains region, but there is not yet general agreement as to placement in this region of the time line that marks the boundary between the Pliocene and the Pleistocene. In order to clarify conflicting points of view and in an attempt to unify usage of time terms in Nebraska and Kansas, the writers of this note, representing the Nebraska Geological Survey, University of Nebraska State Museum, State Geological Survey of Kansas and the Museum of Vertebrate Paleontology of the University of Kansas, during the autumn of 1944 examined in the field some of the significant localities in the Great Plains region of these two states. As a result, the following general stratigraphic relationships and local time classifications were agreed on.

The Tertiary strata of this region exhibit normal stratigraphic relationships (modified by some local channeling)—that is, younger beds overlie older beds in ascending order. On the other hand, the Pleistocene deposits, with exception of deposits in the Meade basin of southwestern Kansas and comparable areas, display a fluvial physiographic sequence; *i.e.*, the oldest deposits occur in high terrace levels and the younger ones occur in successive lower terrace levels. The point in time that marks the end of general upward accumulation of deposits is the close of the period of deposition of the "algal limestone" or "*Chlorellopsis* limestone." This unique limestone bed is generally accepted as marking the close of Ogallala deposition in Nebraska and northern Kansas. There is general agreement among the writers that the events at the close of "algal limestone" deposition were caused by the most important diastrophic episode of late Cenozoic history of the Central Great Plains, but there is lack of agreement as to the correlation of this episode with the standard Pliocene-Pleistocene time line.

In a committee report published in 1941,[3] correlations were suggested for the several vertebrate faunas from the Great Plains and provincial time zones were proposed. The term Blancan, from the Blanco locality in northwestern Texas, was proposed as the late Pliocene provincial time zone to include beds containing the Blanco fauna and faunas of equivalent age. However, in the committee report, Wood and others considered the Broadwater fauna of Nebraska as Pleistocene and the Rexroad fauna of Kansas as Blancan, which they correlated with the late Pliocene,

[1] The manuscript for this note has been read and approved by G. E. Condra, state geologist of Nebraska, and R. C. Moore, state geologist of Kansas, on leave.

[2] Except in parts of western Nebraska and adjacent states where Tertiary formations older than Pliocene are also present.

[3] Horace E. Wood and others, *Bull. Geol. Soc. America*, Vol. 52 (1941), pl. 1.

whereas Kansas and Nebraska paleontologists agree that the Broadwater and Rexroad faunas are equivalent in age and that both faunas correlate with that of the Blanco locality. These beds (Rexroad and Broadwater) occur stratigraphically above the horizon of the "algal limestone" and below the horizon of beds of undoubted Pleistocene age (Meade formation in southwestern Kansas, Grand Island and Upland formations in western Nebraska).

It is here proposed that the placement of the Blancan in either the late Pliocene or in the early Pleistocene of the standard time scale be held in abeyance until there is more general agreement among paleontologists as to its age; and that Blancan be used to serve as a provincial time zone for beds and faunas in the Great Plains region younger than the "algal limestone" and older than beds of undoubted Pleistocene age. The use of Blancan in this sense will serve to clarify current concepts with reference to these beds, will afford a uniform regional classification usable by workers in different states, and will avoid exhaustive controversy about a point of correlation that is not yet subject to conclusive proof. Of course, it is to be hoped that continued study of these beds and faunas will eventually lead to general agreement on correlation with the glacial sections of the Upper Mississippi valley and other parts of the world, and with marine beds, and thus effect a placement of Blancan time within the standard time classification.

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## SPINACH AND BONE FORMATION

IN some experiments designed to test the availability of iodine as contained in certain vegetables, we have had occasion to feed a commercially prepared powdered spinach (Spintrate) to rats as an addition to a diet that had been successfully used by us as a breeding ration over several years (Purina Dog Chow). Since it has been reported that there is some substance, presumably oxalic acid, present in spinach which interferes with the utilization of calcium for bone formation,[1] it seemed of interest to keep records (Table 1) of food consumption and gain in weight of the different groups during the experimental period, and also to determine the ash content of the dried, fat-free leg bones of the animals at termination. Each group consisted of 10 young rats, equally divided as to sex. The experimental period was 35 days.

On the assumption that fresh spinach contains 90 per cent. of water, the rats which received 20 per cent.

[1] M. L. Fincke and H. C. Sherman, *Jour. Biol. Chem.*, 110: 421–428, 1935.

TABLE 1

| Diet | Gain in weight | Daily food intake (Ave.) | Bone ash |
|---|---|---|---|
| Basal ..... | 149 grams | 12.3 grams | 68.3 per cent. |
| 5 per cent. spinach . | 139 | 12.0 | 69.1 |
| 10 per cent. " . | 148 | 12.2 | 67.4 |
| 20 per cent. " . | 141 | 12.3 | 67.9 |

of dried spinach consumed an equivalent of 25 grams of fresh spinach per day, roughly proportional to 2¾ pounds in a human dietary of 2,500 calories. Calcium deficiency manifests itself by either decreased bone-ash or stunting of growth or both. Such effects are absent in the experiment reported, neither is there any decline in appetite or efficiency of food utilization.

Since the basal diet here used is considered to have supplied an adequate amount of calcium for growth, it would seem that spinach, even in such relatively enormous amounts as would never be taken by human beings, would not exert a deleterious effect on growth or on bone formation unless the customary diet of the individual were lacking in calcium.

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## PHOSPHORESCENT TEXAS EARTHWORMS

WHEN going down damp woods earth paths at night the writer occasionally has noticed that bright spots of phosphorescence lighted up in the disturbed soil surface after he passed, glowed for a while and then ceased. He also noticed that by scraping a foot over the area the phosphorescent effect could be repeated an indefinite number of times.

On examination of the path with a flashlight nothing was visible which could have caused the illumination. The tentative conclusion then was that the illumination came from soil bacteria or some other form of invisible microorganism which thus reacted to disturbance. However, the phosphorescence glowed in pea-sized balls, which when raked about remained as units in new positions and glowed brightly. While these balls of light sometimes were thickly placed there was no uniform distribution through the soil such as one might expect if bacteria were the cause. This phosphorescent effect usually had only been noticed during the cool weather of fall or early winter. On the night of December 6, 1944, the closing of the writer's garage door activated some of this phosphorescence when the door scraped the soil surface. The idea then occurred to remove the spots of light and examine them under bright indoor electric lights to see if the cause could be located. The area of phosphorescence was on the edge of a gravel driveway which was covered with a thin film of leaf mold composed of the small leaves of the mesquite tree.

The phosphorescent substance shone in the thin film of soil above the gravel and some of these units of light were removed and examined under strong illumination and the source of each was found to be a small round, slender, pink earthworm varying from one half inch to one and one fourth inches in length and about as large in diameter as the small end of a hardwood toothpick. These earthworms have the same color, general appearance and movements as those of the much larger worms usually known as angle or earthworms. The worms evidently lie coiled on or very near the soil surface and are covered by a very thin film of leaf mold, and when this is moved the worms glow with white light. The night the first specimens were found the temperature was standing at 36 degrees above (Fahrenheit), and when the writer put the tip of his finger on the largest one, which measured one and one fourth inches in length, he thought that it emitted a slightly perceptible amount of heat, and this apparent effect has since been observed. The writer's sense of touch perhaps is above the average and he does not believe that this observation is subjective and he would like to see the matter checked with some delicate heat-recording apparatus. On the next night at 11:50 many more phosphorescent worms were found and the temperature then stood at 38 degrees above (Fahrenheit). On the following morning at 7:30 the temperature stood at 32 degrees above (Fahrenheit) and a heavy frost covered everything. The soil was not frozen, however, and the worms still remained on or just beneath the surface and their lights shone brightly when disturbed.

On bringing the worms indoors into a temperature of 60 degrees above (Fahrenheit) it was found to be difficult to get any phosphorescent reaction out of them, but on taking them back outside into the nearly freezing temperature and dumping them onto the cold earth they again glowed when touched.

To determine whether the phosphorescence was in the body of the worm or in the slimy secretion around it one of the largest specimens was washed in water and the light then did seem weak, but when the body of the worm was crushed against a stone and rubbed over its surface the whole area glowed brightly for some seconds. Of what use the phosphorescence is to the worm the writer is uncertain, but the observations thus far made might indicate that the light-producing mechanism may generate enough heat as well as light to enable the animal to remain active during periods of low temperature which inhibit the activity of most lower organisms.

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## COMPARATIVE UNIVERSITY STRENGTH IN SCIENTISTS STARRED IN "AMERICAN MEN OF SCIENCE" V–VII

THE accompanying table gives in Column I the number of scientists first starred in 1933 to 1944 who were on the faculties of the universities which had three or more such scientists in 1944. These totals were obtained by a check of the 1944 edition, supplemented by changes announced in SCIENCE.

The leading universities in the number of fairly young starred scientists on their faculties are Harvard, California, Columbia, Chicago, Michigan, Princeton, Stanford, Yale, California Institute of Technology, Massachusetts Institute of Technology, Cornell, Illinois, Minnesota, Hopkins and Wisconsin, with totals decreasing from 50 to 13. Most of these institutions possess a somewhat comparable number of older starred scientists, some of whom are still active workers.

Apparently little or no consideration has been given in discussion of comparative scientific strength, of the contrasts in size of the faculties. However, this consideration throws interesting light upon what might be called median faculty strength. In brief, what proportion of the staff are distinguished scientists? The second and third columns of the accompanying table supplement Column I. Column II is the number of

TABLE 1

LEADING UNIVERSITIES AS TO YOUNGER STARRED SCIENTISTS WITH SUPPLEMENTARY DATA

| | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| Brown | 4 | 157 | 2.6 | 8 | 1,500 | 0.5 |
| California | 41 | 2,376 | 1.7 | 30 | 2,500 | 1.1 |
| Calif. Tech. | 20 | 140 | 14.3 | 6 | .... | .. |
| Chicago | 30 | 798 | 3.8 | 36 | 1,500 | 2.2 |
| Columbia | 36 | 2,488 | 1.4 | 13 | 1,900 | 0.6 |
| Cornell | 18 | 1,052 | 1.8 | 21 | 1,100 | 1.8 |
| Duke | 3 | 465 | 0.6 | .. | .... | .. |
| Harvard | 50 | 1,775 | 2.8 | 44 | 2,700 | 1.4 |
| Hopkins | 16 | 765 | 2.1 | 7 | 400 | 1.6 |
| Illinois | 18 | 1,743 | 1.0 | 15 | 1,200 | 1.1 |
| Indiana | 7 | 467 | 1.5 | 5 | 1,300 | 0.3 |
| Iowa | 10 | 622 | 1.6 | 7 | 1,500 | 0.4 |
| Iowa State | 4 | 413 | 1.0 | .. | .... | .. |
| Mass. Tech. | 19 | 442 | 4.3 | 10 | .... | .. |
| Michigan | 30 | 820 | 3.7 | 17 | 3,000 | 0.5 |
| Minnesota | 18 | 836 | 2.1 | 13 | 1,900 | 0.6 |
| N. Carolina | 6 | 311 | 2.0 | .. | .... | .. |
| Northwestern | 12 | 1,330 | 0.9 | 5 | 800 | 0.6 |
| Ohio | 9 | 1,123 | 0.8 | 10 | 1,900 | 0.5 |
| Pennsylvania | 14 | 1,322 | 1.1 | 7 | 1,000 | 0.6 |
| Penn. State | 3 | 864 | 0.3 | .. | .... | .. |
| Princeton | 26 | 220 | 10.2 | 14 | 2,100 | 0.6 |
| Rochester | 7 | 544 | 1.3 | .. | .... | .. |
| Rutgers | 5 | 444 | 1.1 | 3 | .... | .. |
| Stanford | 22 | 645 | 3.4 | 14 | 1,900 | 0.7 |
| Swarthmore | 3 | 91 | 3.3 | 4 | .... | .. |
| Virginia | 6 | 270 | 2.2 | .. | 1,000 | .. |
| Wash. (St. L.) | 6 | 468 | 1.3 | 7 | 600 | 1.0 |
| Wisconsin | 13 | 1,469 | 0.9 | 11 | 1,200 | 0.8 |
| Yale | 22 | 994 | 2.2 | 18 | 1,200 | 1.4 |

the members of the teaching staff on November 1, 1944, as officially supplied to Raymond Walters for his "Statistics of Attendance in American Universities"

(*School and Society*, December 23, 1944). It shows that the teaching staffs of Columbia and California include more than 2,300 persons, while several other universities have more than a thousand teachers. Conversely, some strong schools have fewer than 300 staff members.

Column III is the number of scientists starred in 1933–1944 per 100 members of the 1944 teaching staff. It indicates that in this respect the leading universities are the California Institute of Technology, Princeton, Massachusetts Institute of Technology, Chicago, Michigan and Stanford. Thus the three leaders in total numbers (Column I) fall behind the fourth (Chicago), but three which are among the second five in Column I lead in Column II, and seven surpass Harvard. This is possible because these three specialize in the sciences in which starring is done, while Chicago, Harvard and Columbia, for example, offer instruction in many fields not recognized by starring, the humanities, and the social sciences, law, education and divinity, for example. Column III gives support to the claims of alumni of certain other schools that Harvard's average scientific faculty strength is not as great as Princeton's or Chicago's, for example, despite its leadership in the number of starred scientists on its staff.

Another manner of rating the strength of institutions in so far as it is revealed by starred scientists is the number of alumni who win stars. Collegiate alumni are considered in Columns IV, V and VI. Column IV is the number of scientists first starred in 1933, 1937 or 1944 who received their college degree at the institutions in this list which graduated three or more. It shows that Harvard led with 44 such alumni, followed by Chicago 36, California 30, Cornell 21 and Yale 18. Since enrolments vary widely, an effort has been made to discover the output in proportion to enrolments.

Column V is the approximate number (nearest 100) of undergraduate college men in attendance November 1, 1922, according to Raymond Walters' report (*School and Society*, February 24, 1923). The approximate median date of graduation of these scientists is 1922.

Column VI is a ratio between attendance and starred collegiate alumni. It is based on the reasonable assumption that the 1922 enrolment of men in the college was approximately the average number enrolled during the years when most of the scientists who were starred in 1933–1944 graduated from college. The numeral is the approximate number of starred college alumni per 1,000 male college students. It was obtained by dividing eleven times the enrolment into the number of starred college alumni (the starring was spread over eleven years). Men only are considered, as very few women won stars—only 4 of the 250 starred in 1944. College men, instead of all undergraduate men, are considered because most starred men attended the college rather than the schools of agriculture, engineering or education, for example.

According to the information at hand, presented in Column IV–VI, the leading colleges in the yield of starred alumni of the last three starrings in proportion to size are Chicago, Cornell, Hopkins, Harvard and Yale, with Chicago doing about 50 per cent. better than Harvard or Yale.

Other colleges which have had relatively many of their college alumni starred lately, but for which data comparable to those in Table I are not at hand, are Amherst, California Institute of Technology, Dartmouth, Denison, Haverford, Missouri, Nebraska, Pomona, Oberlin and Swarthmore.

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## THE SOCIETY FOR FREEDOM IN SCIENCE

IT has come to our knowledge that statements have been made in the United States alleging that the Society for Freedom in Science is partly a political organization. Such allegations are completely untrue. The society includes members of all shades of political opinion from Conservative to Socialist. It opposes totalitarianism in the sphere of science whatever the political complexion of the Government imposing it.

J. A. CROWTHER
A. G. TANSLEY
JOHN R. BAKER, *Secretary*
*Executive Committee of the Society*

# SCIENTIFIC BOOKS

## CLIMATOLOGY

*Methods in Climatology*. By VICTOR CONRAD. 228 pp + x, 3 App. Index, 46 figs. and 46 tables. Harvard University Press. 1944. $4.00.

THE impact of weather on military strategy and tactics in the present global conflict has confronted innumerable planners and operators, journalists and scientists with "practical" problems in applied climatology—a field which *ante bellum* meagerly supported only a very small "profession." Dr. Conrad's book therefore appears before an eager group of consumers for whom no other adequate guide book on climatological method is available in English. However, readers expecting instructions for correlating clima-

tological phenomena with technological or biological data, and especially suggestions for the solution of forecasting problems, probably will find themselves rather disappointed in this book, for the author has not set himself any such utopian objective.

The author perhaps should have selected a title with narrower connotations, for the aim of his methods is mainly the traditional one of Hann and the "Austrian School" of climatologists, who have concerned themselves first and primarily with objective methods of *description* of the average state of the atmosphere (*i.e.*, the climate). The chief task has been to make the series of meteorological observations taken at various places over the earth comparable, preliminary to analyzing the results for "laws" of distribution and relationship. The influence of Hann and Köppen in the latter part of the last century brought the meteorological services together in international conventions which standardized observational methods, as well as the forms of summarizing and publishing results of observations. The next objective was to generalize these published results of observations, in maps and graphs, for homogeneous periods and given epochs, and to find rational explanations for this *climatography*. Principles so derived offered possibilities of extrapolating and interpolation in time and space where observations may be lacking. In a generation such work created a lovely self-contained system of knowledge.

But during the last three decades these rigid traditions have tended to cramp the growth of climatology. For in recent years the rapid development of synoptic meteorology and of the ecological sciences have beckoned climatology into new directions for which the classical methodology does not well provide. However, the original aim of describing the world's climates has meanwhile only very partially been achieved. The disciples of Hann and Köppen, of whom Dr. Conrad is now the acknowledged leader, have not lost sight of the fundamental place that an objective-comparative-descriptive climatology will always hold. Ecological and applied climatology must start from that foundation even though they aim very far afield from it. For this reason "Methods in Climatology" is a much needed type of work. It is particularly welcome in this country because no professional book on the subject has heretofore existed in English, for which reason too much of the American university and collegiate training in the subject has been provincial and shallow.

Dr. Conrad had published a methodological treatise in Germany in 1936 (Köppen-Geiger, "Handbuch der Klimatologie," Bd. I, Teil B), the first of its kind in any language since Hugo Meyer's pioneer little handbook of 1891. The high price of the German book and the language barrier have prevented its wide use in English-speaking countries. Dr. Conrad has now written an entirely new book in English, arranging his materials in a form more suitable for American students. Detailed examples and bibliographical references, so numerous in his German work, are kept to a minimum and selected as far as possible from literature in English. Unfortunately, the kind of climatology outlined can only be well exemplified by reference to Continental literature; that in English fits into the scheme very spottily at best.

American students will no longer have any excuse for omitting from their background the spirit and methods of the very productive German and Austrian climatologists. American climatologists have not been uninfluenced by the European methods, but the economic and academic conditions in this country have not offered much encouragement for such detailed and often rather abstract types of analysis. The late Dr. O. W. Fassig, who had studied with von Bezold and Hellmann at Berlin in the golden age of German meteorology, produced upon his return to this country an elaborate monograph after the German model ("The Climate of Baltimore," 1908). It is still a very suggestive work from the methodological point of view, but, alas, seems to be little known. Other Americans of the last generation, such as R. de C. Ward, W. M. Davis, Cleveland Abbe, F. H. Bigelow, were much stimulated by European methods, and more recently C. F. Brooks has carried on their tradition. Ward's translation of Hann's "Treatise on Climatology" (1903) has long been a "bible," though it is only by inference a methodology. Conrad's book brings us up to date.

It is organized in three parts. Part I, "General Methods," is largely devoted to statistical methods for defining the homogeneity and elementary characteristics of series of observations; extremes, averages, frequency curves, variance, curve fitting and harmonic analysis. Most of this part is not peculiar to climatology and can be gotten from elementary statistics text-books. For one already familiar with statistical methods, these pages will only serve to illustrate what methods have been generally used by European climatologists, whereas the reader untutored in statistics will probably not always find sufficient explanation to properly understand the procedures. Part II, "Representation of Characteristic Features of Different Elements," reviews examples of statistical characteristics of the elements: temperature, pressure, water vapor, wind, cloudiness, precipitation, etc.—at a given point. This, the real meat of the book, will be the part of most interest to both specialists and general readers, since it illustrates typical results found in the large and scattered literature. One gets an idea of what has been tried but seldom a hint as to what else needs to be done.

Part III, "Methods of Spatial Comparison," is an extension of Part II to indicate how statistical characteristics of the elements at one point are to be compared with those at other points. This includes reduction to standard period and epoch, correlation coefficients, graphs, maps, anomalies, roses and streamlines. Included here are integrated or synthetic elements such as continentality, air-mass climatology and climatic boundaries. Unfortunately, the discussion of and examples of streamlines are not very sound nor sufficiently explicit, but the matter is not of great importance. Part IV, "The Climatography," indicates briefly the desired type and organization of contents of a monograph on the climate of a region.

There is much room for difference of opinion as to the proper methods to use in a descriptive climatology. This review is not the place to introduce other approaches; but we do miss any reference to the new Russian methods. Dr. Conrad has given us an excellent account of the methods found in the German literature, to which he himself has made many interesting contributions, and organized them according to a well-established and consistent point of view. It will be a firm starting point for the new generation of climatologists now emerging.

R. G. STONE

## ANALYTICAL GEOMETRY

*Analytical Geometry of Three Dimensions.* By W. H. McCREA. (University Mathematical Texts, No. 7.) vii + 144 pp. Edinburgh: Oliver and Boyd. New York: Interscience Publishers. 1942. $1.75.

THIS is a remarkably concise exposition which is at the same time rigorous and easy to read. It could not be recommended (and was not intended) for a student who has no supplementary help; but it is a university text, which means that it will, as the author says, "be used in connection with lectures or other personal instruction." The opening chapters, on "Directions, Planes and Lines," and "The Sphere," are orthodox but neatly expressed. (The third includes a good account of stereographic projection.) Then "Points at Infinity" are introduced in an unusually careful manner. Homogeneous coordinates are used to determine a space $\bar{\mathcal{E}}$, part of which is isomorphic with the Euclidean space $\mathcal{E}$ previously considered. The remaining "special" points of $\bar{\mathcal{E}}$ are defined on page 43, but it is not until page 51 that our suspense is relieved by the proof that "two ordinary lines are parallel if and only if they meet in a special point."

Chapter V may seem more difficult to some readers, but a careful study of it will be found well worth while. Here quadrics are classified first in $\bar{\mathcal{E}}$ and then in $\mathcal{E}$. The results are very neatly tabulated. The general quadric is denoted by

$$a_{rs}\, x_r\, x_s = 0$$

in accordance with Einstein's convention of summation. Chapter VI, on Standard Forms, is enlivened by instructions for making solid models. The final chapter deals interestingly with some extra topics such as twisted cubics and confocals. In particular, a focus of a quadric is defined (on page 134) as a point which is the vertex of a single infinity of orthogonal conjugate trihedra. It is proved that the foci constitute an ellipse in one plane and a hyperbola in another and that any focus which lies on the quadric is an umbilic.

To quote the author's preface again, "Care has been taken to frame the theory so that it does strictly apply to *real* space. This explains the avoidance of certain familiar short-cuts, which actually depend on jumping difficulties about reality conditions."

Possibly more use might have been made of the duality (in $\bar{\mathcal{E}}$) between point-coordinates and plane-coordinates (compare P. W. Wood's tract on "The Twisted Cubic," Cambridge, 1913, or A. Robson's "Introduction to Analytical Geometry," Cambridge, 1940, where this duality is indicated by the consistent interchange of small and capital letters). The author shows on page 70 that "the necessary and sufficient condition for a plane to be a tangent plane is that it should contain its pole," and that the pole of a given plane $[\xi_1, \xi_2, \xi_3, \xi_4]$ is obtained by solving the equations

$$a_{rs}\, y_r = \xi_s.$$

The customary work on page 84 could have been simplified by carrying out this solution in the form

$$y_s = b_{rs}\, \xi_r,$$

which shows that the condition for $\xi$ to contain its pole is

$$b_{rs}\, \xi_r\, \xi_s = 0.$$

Again, the cross ratio of four collinear points (page 52) and of four coaxial planes (page 53) might have been deduced simultaneously from the expression

$$\frac{(\xi \cdot \mathbf{x})(\eta \cdot \mathbf{y})}{(\xi \cdot \mathbf{y})(\eta \cdot \mathbf{x})}$$

which is valid for any two points and two planes $\mathbf{x}, \mathbf{y}, \xi, \eta$.

But these are minor criticisms, and on the whole this is probably the best text-book ever provided for university teaching of analytical stereometry. The printing is excellent. Apart from some missing letters at the beginning of two lines on page 130, the only error detected was the transposition in "Joachimstahl" on page 59. Finally, there is a good index.

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## COLORIMETRIC DETERMINATION OF TRACES OF METALS

*Colorimetric Determination of Traces of Metals.* By E. B. SANDELL. 487 pages, with index. Cloth

bound. New York: Interscience Publishers, Inc. 1944. $7.00.

THE first part of this book describes theory and practice of colorimetry and covers the subject of sampling, reagents, blanks, and the preparation of solutions. About a score of general colorimetric reagents, including dithizone, thionalide and hydrogen peroxide, are discussed.

The second part, from page 113 to the index, consists of procedures for the determination of traces of metals. The author has adopted the desirable practice of showing how to separate interfering elements so that the reader can see the limitations as well as the applicability of the methods. The discussions include quite a range of determinations, for example, chromium in silicate rocks, in iron ore, and in biological materials; lead in silicate rocks, in water, and in biological materials; and rhenium by various methods in molybdenite and pyrolusite. Usually more than one method is given so that the analyst has some choice depending upon the nature of the substance to be analyzed.

To an analyst it is always gratifying to read a book or use a method that conveys the feeling that the subject-matter is based on the experience of the author. This is such a book and should find a place on the desk of any analyst interested in the determination of traces of metals. It is to be regretted that more elements are not included, especially the more common non-metals that are so common in silicate rocks and metallurgical products. Another volume including these is desirable.

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# SPECIAL ARTICLES

## ON THE NATURE OF REFRACTORINESS OF CERTAIN GRAM-NEGATIVE BACILLI TO PENICILLIN[1,2,3]

GRAM-NEGATIVE bacilli are described as highly resistant to penicillin,[4] the fact being interpreted as an intrinsic difference between Gram-negative bacilli and the susceptible Gram-positive microorganisms. It was recently reported by the author of this article that *E. coli* is significantly more susceptible to the drug than hitherto assumed. The inhibitory effect may be obscured by tests against an excessively large number of organisms, the bacterial concentration at zero hours bearing a linear relationship to the concentration of penicillin producing complete inhibition. Furthermore, the susceptibility of *E. coli* could be significantly enhanced when the tests were made in mixtures of methionine with normal sera.[5] The observations suggested that the refractoriness of Gram-negative bacilli may at least in part result from the interference of some medium-ingredients or bacterial metabolites with the action of penicillin. In order to investigate this assumption autotrophic strains of Gram-negative bacilli, *i.e.*, capable of growing abundantly in synthetic media with ammonium as sole source of nitrogen, were selected for study. The measurements of penicillin activity were made in the manner previously described.[5] The organisms were cultured for a number of generations in the synthetic medium of Gladstone.[6] The same medium was used as diluent and for testing. As may be seen from Table 1, the susceptibility of the organisms to penicillin was markedly greater in the synthetic medium than in meat infusion broth. The following studies were made in order to determine the nature of the antagonism observed.

TABLE 1

COMPARISON OF INHIBITORY EFFECT OF PENICILLIN UPON E. COLI IN MEAT INFUSION BROTH AND SYNTHETIC MEDIUM (GLADSTONE)

| Microorganism* | Medium | Penicillin in O.U./ml giving complete inhibition | Coefficient resistance† | Increase in susceptibility in Gladstone medium |
|---|---|---|---|---|
| *E. coli* No. 42 | Broth | 20 | 1000‡/50 | 20× |
| | Gladstone | 1 | | |
| *E. coli* No. 742 | Broth | >50 | >2500/500 | >5× |
| | Gladstone | 10 | | |
| S. Newport | Broth | 2 | 100/10 | 10× |
| | Gladstone | 0.2 | | |
| S. Paratyphi B | Broth | 3 | 150/75 | 2× |
| | Gladstone | 1.5 | | |
| S. Enteriditis | Broth | 8 | 400/50 | 8× |
| | Gladstone | 1 | | |

* The number of organisms at zero hours was $0.75 \times 10^8$ per ml.

† Taking as one unit of resistance the amount of penicillin required to produce complete inhibition of Staphylococcus H, $5 \times 10^8$ organisms per ml at zero hours.

‡ Lower concentrations of penicillin are required to inhibit smaller numbers of organisms at zero hours.[6]

[1] From the Division of Bacteriology, Laboratories of the Mount Sinai Hospital, New York, N. Y.

[2] The author wishes to acknowledge thankfully the accurate and capable assistance of Miss Alice Fisher.

[3] The penicillin was provided by the Office of Scientific Research and Development from supplies assigned by the Committee on Medical Research for clinical investigations recommended by the Committee on Chemotherapeutics and Other Agents of the National Research Council.

[4] E. P. Abraham, *et al.*, *Lancet*, 2: 177, 1941; J. Florey, *Brit. Jour. Exp. Path.*, 23: 120, 1942; C. L. Hobby, R. Meyer and E. Chaffee, *Proc. Soc. Exp. Biol. and Med.*, 50: 281, 1942.

[5] Gregory Shwartzman, SCIENCE, 100: 477, 1944.

[6] G. P. Gladstone, *Brit. Jour. Exp. Path.*, 18: 322, 1937.

*Anti-penicillin effect of casein hydrolysate:* Casein hydrolysate[7] of a given concentration was added to Gladstone medium containing various amounts of penicillin; as well as various concentrations of the casein were tested against 1.5 O.U. of penicillin representing 1.5 times the amount necessary for complete inhibition of *E. coli,* strain No. 42, in Gladstone medium alone. The initial number of organisms was $0.75 \times 10^6$ cells per ml. In the presence of $2.5 \times 10^{-3}$ and $1.25 \times 10^{-3}$ ml of casein there were required 15 and 7.5 times greater amounts of penicillin, respectively, than in the absence of casein (*i.e.,* 15 and 7.5 O.U. as compared to 1 O.U.). Furthermore, $1.25 \times 10^{-4}$ ml of the hydrolysate was capable of antagonizing 50 per cent. of the activity of 1.5 O.U. of penicillin per ml. It is obvious from the above that casein hydrolysate is an active antagonist of the effect of penicillin upon *E. coli.*

*Effect of certain amino acids and asparagine upon inhibition of E. coli by penicillin:* In this group of experiments there was studied the effect of various concentrations of some of the amino acids[8] entering into composition of casein hydrolysate and that of asparagine[8] upon the inhibition of *E. coli* by different concentrations of penicillin in synthetic medium. Glycine, $1.5 \times 10^{-2}$M and $0.75 \times 10^{-2}$M; histidine, $2 \times 10^{-4}$M; phenylalanine, $6 \times 10^{-4}$M; and serine, $1 \times 10^{-4}$M produced a somewhat variable antagonistic effect upon the minimal inhibitory dose of penicillin in synthetic medium (*i.e.,* 1 O.U. per ml), little effect having been observed with greater concentrations of penicillin. Glutamic acid, $6.2 \times 10^{-3}$M, possessed a greater but also variable anti-penicillin property. However, a distinct antagonism against penicillin was shown by asparagine. Thus 2 mg per ml of the substance completely antagonized the effect of 1 O.U., 50 per cent. of 1.5 O.U., 10 per cent. of 3 O.U. and 2 per cent. of 6 O.U. of penicillin. Valine, $1 \times 10^{-2}$M and $0.5 \times 10^{-2}$M, and methionine, $2.5 \times 10^{-2}$M, were totally devoid of anti-penicillin activity in Gladstone medium. It is evident that the anti-penicillin property of the substances described bears no relation to molar concentration and nitrogen contents.

*Effect of dl-methionine upon anti-penicillin activity of casein hydrolysate and asparagine:* In synthetic medium alone methionine failed to enhance the susceptibility of *E. coli* beyond one O.U. per ml. Methionine, $2.5 \times 10^{-2}$M, appeared capable of removing 50 to 60 per cent. of the anti-penicillin activity of casein hydrolysate, $1.25 \times 10^{-4}$ ml and about 75 per cent. of the activity of asparagine, $1.5 \times 10^{-2}$M.

[7] Manufactured by SMACO as "Vitamin-free" Acid Hydrolysed Casein for use in culture media.

[8] l-Histidine, Hoffmann La Roche; dl-Serine, Eastman Kodak; Glycine, l(+)Glutamic acid, dl-Methionine, dl-Phenylalanine and dl-valine, SMACO; and Asparagine, Difco standardized.

*Relation of rate of growth of E. coli to the penicillin effect of broth and casein digest:* In these experiments there was studied at frequent intervals of time the optical density of cultures of *E. coli* in Gladstone medium alone, Gladstone medium containing various concentrations of casein hydrolysate and in meat infusion broth. The same inoculum was used in all media, all other conditions having been kept as uniform as possible (*i.e.,* size of tubes, amount of medium, H-ion concentration, etc.). In the absence of penicillin there was less than 10 per cent. difference in bacterial concentration of all the cultures studied at the expiration of 16 hours of incubation at 37° C. The initial lag period was 3½ to 4 hours. The generation time was 2 to 3 times longer during the initial 3 hours of the log phase in cultures made in the Gladstone medium than in the remaining media. Delay in growth is known to antagonize the effect of penicillin.[9] Inasmuch as the prolongation of generation time occurred in Gladstone cultures, obviously the fact could not be held responsible for the greater activity of penicillin in these cultures. In order to bring further support to this contention, a series of tubes with casein hydrolysate in Gladstone medium, and the same mixture containing 1.5 O.U. penicillin per ml were placed in the refrigerator for periods of time varying from zero to 5 hours prior to incubation at 37° C. for 16 hours. Variations in the amount of growths in the respective tubes did not exceed 5 per cent. It may be concluded that the differences in penicillin activity observed were not caused by changes in the rate of growth in the media used.

*Summary:* The susceptibility of certain strains of *E. coli* and Salmonella is significantly greater in synthetic medium than in meat infusion broth. Casein hydrolysate, asparagine, glutamic acid to a lesser degree, and possibly some other aminoacids partially antagonize the effect of penicillin upon *E. coli* in synthetic medium. The antagonism of casein hydrolysate and asparagine can be removed in greater part by methionine. The observations suggest that the refractoriness of Gram-negative bacilli to penicillin is at least to some extent extrinsic in nature.

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## THE CHANGES IN RAT KIDNEY COCARBOXYLASE ASSOCIATED WITH THE INJURIOUS EFFECTS OF dl-SERINE[1, 2]

AN injurious action of *dl*-serine in rats has been observed following its administration by stomach tube[3]

[9] M. H. Dawson, *et al., Jour. Clin. Invest.,* 20: 434, 1941; G. L. Hobby and M. H. Dawson, *Proc. Soc. Exp. Biol. and Med.,* 56: 178 and 181, 1944; C. P. Miller and Foster A. Zimmerman, *Proc. Soc. Exp. Biol. and Med.,* 56: 205, 1944.

or by parenteral injection.[4] Clinically, the animals exhibited anorexia, a rapid loss in weight, albuminuria and marked weakness. Death occurred in over 50 per cent. of the male animals between the third and the eighth day of serine administration. Pathologically, the most characteristic findings were severe necrotizing lesions of the kidney tubules.[5]

The mechanism of the production of the toxic action of serine is still very obscure. We do know that a sudden elevation of the level of serine in the blood and tissues is necessary for serine to exert its injurious action.[4, 6] It is conceivable, therefore, that some essential metabolic process may be hampered. Thus, the serine molecule may exert a mass action effect on certain essential respiratory enzymes; *e.g.*, it may behave as a competitive inhibitor. The resultant breakdown of these important enzyme systems would lead to tissue damage and necrosis.

One of us had noted in unpublished work connected with other studies,[7] that several amino acids are apparently able to function as energy rich[8] phosphate carriers for the synthesis of cocarboxylase in anaerobic liver homogenate. On the basis of this observation and other considerations, we were led to investigate the cocarboxylase systems of rat kidney as affected by serine administration.

Experiments are described here which show: (*a*) the effect of orally administered serine on the concentration of cocarboxylase in rat kidney *in vivo*. (*b*) the effect of orally administered serine on the disappearance of cocarboxylase in anaerobic rat kidney homogenate *in vitro* (probably dephosphorylation of cocarboxylase and possibly a measure of cocarboxylase phosphatase activity).[7]

## Experimental

Albino rats (Rockland) weighing between 120 and 190 grams, in groups of three or more animals, were maintained on an experimental diet consisting of "Labco" vitamin-free casein 10 parts, dextrin 37, sucrose 37, Crisco 5, cod liver oil 5, "Ruffex" 2 and salt mixture (Osborne and Mendel) 4. After seven days on this diet, certain groups received 100 milligrams of *dl*-serine (Merck), administered by stomach tube daily for periods of four or more days. Other groups on a stock diet (Rockland rat diet, complete), received the amino acid in a similar manner. Control groups of animals on both diets not receiving serine are included.

At the end of the experimental period the animals were decapitated, and the kidneys rapidly weighed and homogenized in a modified Potter and Elvehjem apparatus (Scientific Glass Apparatus Company). Cocarboxylase was determined by the Warburg technique, using the split enzyme as described by Green *et al.*[9] In each experiment, the level of the cocarboxylase present in the fresh homogenate and that remaining after 1 hour at 37° C under $N_2$ in the presence of thiamin (100γ/cc final concentration), and sodium pyrophosphate (0.01 M final concentration), was obtained. The samples were shaken in Warburg vessels during the period of incubation. In a number of experiments, the influence of *dl*-serine (0.05 M final concentration) added to the homogenate, on the cocarboxylase present in the tissue was studied. Cocarboxylase is expressed as γ/gram of dry tissue.

## Results

The administration of serine to rats on the stock diet (Fig. 1a) resulted, after two doses, in a fall of cocarboxylase from 50 γ/gm to 34 γ/gm or to 68 per cent. of the amount normally present in the rat kidney. A return to the normal level takes place by the fourth day.

In the control groups on the experimental diet (Fig. 2a), there was a progressive decrease in kidney cocarboxylase. This may be explained by the reduced intake of thiamin, since the animals here are on a vitamin B deficient diet. However, serine administration resulted in a further decrease in the cocarboxylase. Unlike similar groups on the stock diet, there was no return to normal levels.

The effect of anaerobic incubation on the cocarboxylase level of the kidney homogenate is indicated in Figs. 1b and 2b. In the groups which received serine on the stock diet, the relative amount of cocarboxylase remaining unchanged in the digest after incubation increased to a maximum by the second day and thereafter returned to the resting level. As for the corresponding groups on the experimental diet, a similar phenomenon was evident. Thus again the breakdown of cocarboxylase was least on the second day.

Although it is not indicated in the figures, the addition of serine to the homogenate of kidney from animals on the stock diet or experimental diet in the absence of orally administered serine, resulted in no significant or characteristic change. However, in some

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[1] From the Departments of Biochemistry and Pharmacology, The Bowman Gray School of Medicine, Winston-Salem, N. C.

[2] This investigation was aided by a grant from the John and Mary R. Markle Foundation.

[3] W. H. Fishman and C. Artom, *Jour. Biol. Chem.*, 145: 345, 1942.

[4] W. H. Fishman and C. Artom, *Federation Proceedings*, 3: 10, 1944.

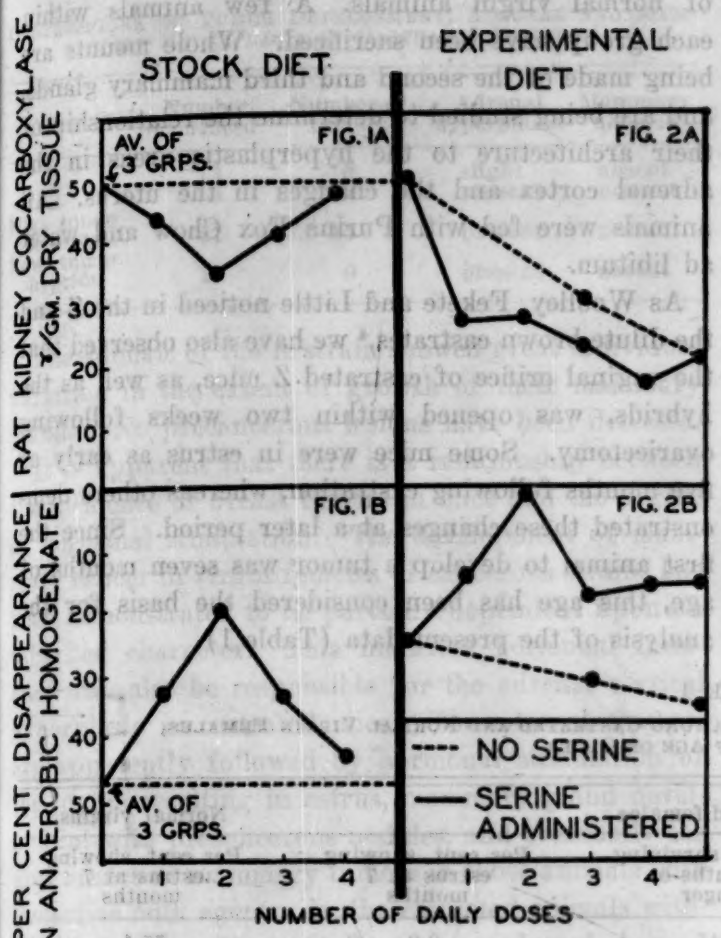
[5] R. P. Morehead, W. H. Fishman and C. Artom, *Am. Jour. Path.*, in press.

[6] C. Artom and W. H. Fishman, *Proc. Soc. Exp. Biol. and Med.*, 57: 239. 1944.

[7] Wm. M. Govier and Margaret E. Greig, *Jour. Pharmacol. and Exper. Therap.*, 79: 240, 1943.

[8] F. Lipmann, *Adv. Enzym.*, 1: 99, 1941.

[9] D. E. Green, D. Herbert and V. Subrahmanyan, *Jour. Biol. Chem.*, 138: 327, 1941.




Changes in rat kidney cocarboxylase in animals receiving *dl*-serine. In figs. 1a, 1b, males (150 to 190 grams) were employed, as deaths due to serine have not been observed in rats on stock diet.[3] In figs. 2a, 2b, most of these groups consisted of smaller female rats (120 g) since on the experimental diet their mortality is less upon serine administration as compared to male rats.[3] Both these measures permitted the experiments to be completed satisfactorily. With respect to the changes in cocarboxylase, unpublished experiments have shown no sex difference.

kidney homogenates from animals on experimental diet which had received oral serine, it was possible to show more cocarboxylase in the digest than in the fresh tissue (in one case, an increase of 32 per cent.). The pyrophosphate and thiamin added to the homogenate represent the source of the extra cocarboxylase.

## Discussion

In the animals receiving serine there are two phenomena evident, the reduction in kidney cocarboxylase *in vivo*, and a lessened tendency for this substance to disappear from the homogenate on anaerobic incubation *in vitro*. These biochemical events may now be correlated with the pathological findings.[5] The first dose of serine leads to profound necrotizing lesions in the kidneys of rats on either experimental or stock diets. At this time there occurs a drop in cocarboxylase and a reduction in the breakdown of cocarboxylase in anaerobic homogenate. Processes of repair are very extensive and almost completed by the fourth day in animals on the stock diet, and here we see a return to normal of the tissue cocarboxylase and of the rate of its disappearance on anaerobic incubation. In the animals on the vitamin B deficient diet, however, the kidneys never return to their former healthy state and the necrotic tissue is replaced by calcium deposits. Here we find no return to normal cocarboxylase levels or to a normal rate of its disappearance on incubation.

With reference to the reduction of kidney cocarboxylase *in vivo*, there may be several explanations, all equally worthy of consideration. Thus, the diminution in cocarboxylase may be the result of tissue damage, normal levels (Fig. 1a) returning when the tissue is repaired. Again, the observations may be ascribed to a specific involvement of cocarboxylase in serine metabolism, or perhaps to an indirect action of the amino acid on tissue respiratory systems. At present, there is no direct evidence which would permit us to select any one hypothetical mechanism in preference to the others.

In the case of the lessened tendency of cocarboxylase to disappear in homogenates from animals receiving oral serine, and where actual cocarboxylase synthesis occurs in the presence of added serine, the mechanisms involved seem even more obscure. One has the feeling, however, that these reactions involve the functioning of tissue cocarboxylase phosphatase.

## Summary

When rats on either a stock or a vitamin B deficient diet are given the amino acid *dl*-serine by stomach tube, there is a fall in the cocarboxylase concentration of the kidney. This organ exhibits marked damage. There is, also, a lessened tendency for cocarboxylase to disappear from the tissue homogenate upon anaerobic incubation *in vitro*. In animals on the stock diet, only, there is a recovery of the normal cocarboxylase level. The probable relation of these findings to the mechanism of the production of the injurious action of serine is discussed.

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## CASTRATION EFFECTS OF THE INHERITED HORMONAL INFLUENCE[1, 2]

WOOLLEY, Fekete and Little[3, 4] observed evidence of

[1] A preliminary report of material being compiled for a thesis in partial fulfilment of the requirements for the degree of doctor of philosophy at the University of Minnesota.

[2] Aided by a grant from the Graduate School Cancer Research Fund made to Dr. Bittner.

[3] E. Fekete, G. Woolley and C. C. Little, *Jour. of Exp. Med.*, 74: 1–8, 1941.

hormonal stimulation in mice of the cancerous dilute brown and C3H stocks that had been castrated shortly after birth. Because of the hyperplastic changes noted in the cortex of the adrenals, it was believed that there was the source of the hormonal stimulation in the absence of the gonads. Spontaneous mammary carcinomas were found in castrated mice of both strains.

Since both the C3H or Z and the dilute brown mice used by the workers cited have a high incidence as virgins, it seemed advisable to study the influences active among castrates of two high tumor strains which differ in the incidence of mammary cancer in the breeding and the virgin state. For this purpose, female mice of the high cancerous A and C3H stocks were chosen. As breeders, mice of both of these strains show a high cancer incidence.[5, 6] As virgins, however, the A females have a low incidence[7] in contrast to the much higher percentage reported for the Z or C3H stock.[8] The variation in the incidence between the virgins of these two strains has been found to be caused by a difference in genetic factors,[9, 10] and the character has been termed the inherited hormonal influence.

In the present study the mice under observation include females of these two high tumor strains as well as reciprocal hybrids. Some of the hybrids have the active milk agent and are called high tumor hybrids; those without this agent are considered as low tumor hybrids. The mice employed were castrated at approximately four weeks of age. Vaginal smears were then made at six-week intervals to secure evidence of hormonal stimulation. There was an additional two-week period of daily observation of the vaginal response of the castrate mice and of comparable groups of normal virgin animals. A few animals within each group have been sacrificed. Whole mounts are being made of the second and third mammary glands, and are being studied to determine the relationship of their architecture to the hyperplastic areas in the adrenal cortex and the changes in the uterus. All animals were fed with Purina Fox Chow and water ad libitum.

As Woolley, Fekete and Little noticed in the Z and the dilute brown castrates,[4] we have also observed that the vaginal orifice of castrated Z mice, as well as the hybrids, was opened within two weeks following ovariectomy. Some mice were in estrus as early as five months following castration, whereas others demonstrated these changes at a later period. Since the first animal to develop a tumor was seven months of age, this age has been considered the basis for the analysis of the present data (Table 1).

TABLE 1

OBSERVATIONS UPON THE OCCURRENCE OF ESTRUS AMONG CASTRATED AND NORMAL VIRGIN FEMALES, SEVEN MONTHS OF AGE OR OLDER

| Stock | Castrated females | | | Normal virgins |
|---|---|---|---|---|
| | Total number under observation | Number surviving 7 months or longer | Per cent. showing estrus at 7 months | Per cent. showing estrus at 7 months |
| A | 79 | 45 | 0.0 | 75.4 |
| Z | 66 | 46 | 69.5 | 75.0 |
| High tumor hybrids | 133 | 99 | 79.0 | 90.5 |
| Low tumor hybrids | 73 | 73 | 76.7 | ...* |

* None studied.

The mice of the A strain were strikingly different. They rarely showed an opening of the vaginal pore until at least six months after castration and no estrus cycles have as yet been observed among the castrates.

Among the mice which have been sacrificed, the Z mice and the hybrids, including those without the milk agent, have enlarged cystic uteri well supplied with blood vessels. There was gross and microscopic hyperplasia of the adrenal cortex. The uteri of the mice of the A strain were all small with no evidence of stimulation. The adrenals were also normal in their gross appearance and only two animals showed beginning hyperplasia. A complete analysis of the histological details will be presented in another report.

The mammary glands of all the Z and the hybrid mice showed extensive duct development and indications of active growth in the end bulbs. There was very slight lateral branch expansion. Precancerous nodules were observed as was spontaneous mammary cancer in mice of the Z stock and the hybrids with the milk agent (Table 2). Although the hybrids without the milk agent showed adrenal changes and mammary gland development comparable to the high tumor animals, no precancerous nodules have been observed and it is expected that no mammary tumors will develop.

[4] G. W. Woolley, E. Fekete and C. C. Little, *Proc. Soc. Exp. Biol. and Med.*, 45: 796–798, 1940.
[5] J. J. Bittner, *Canc. Res.*, 3: 441–447, 1943.
[6] *Idem*, *Canc. Res.*, 4: 159–167, 1944.
[7] *Idem*, *Pub. Health Rep.*, 54: 1113–1118, 1939.
[8] M. B. Visscher, Z. B. Ball, R. H. Barnes and I. Sivertsen, *Surgery*, 11: 48–55, 1942.
[9] J. J. Bittner, R. Huseby, M. B. Visscher, Z. B. Ball and F. Smith, SCIENCE, 99: 83–85, 1944.
[10] W. E. Heston and H. B. Andervont, *Jour. Nat. Canc. Inst.*, 4: 403–409, 1944.

TABLE 2

OBSERVATIONS OF TUMOR DEVELOPMENT, ADRENAL AND MAMMARY HYPERPLASIA IN CASTRATED FEMALES

| Stock | Number sacrificed | Number of tumors | Adrenal hyperplasia | Mammary nodules |
|---|---|---|---|---|
| A .... | 13 | 0 | slight | absent |
| Z .... | 4 | 4 | present | present |
| High tumor hybrids . | 27 | 15 | present | present |
| Low tumor hybrids . | 11 | 0 | present | absent |

The animals of the A strain showed great individual variation in the extent of growth of their mammary glands. No precancerous lesions have been detected.

It is apparent that there is a relationship between the incidence of breast tumors in mice and the degree of hormonal stimulation. The development of mammary cancer in virgin females of cancerous strains has been demonstrated to be partially dependent upon an inherited character. This inherited hormonal influence may also be responsible for the adrenal cortical hyperplasia in castrated mice. The adrenal changes are apparently followed by hormonal stimulation of the uterus resulting in estrus, mammary gland development with precancerous nodules, and eventually the appearance of mammary tumors in those animals with the active milk agent. In the castrated animals without the active milk agent there were adrenal changes but precancerous lesions and mammary tumors have not appeared. Castrated animals having the milk agent but not the inherited hormonal influence may show modified adrenal changes but no other evidence of hormonal stimulation.

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## QUININE ACTION IN BACTERIAL GROWTH AND DISINFECTION[1]

RECENT studies of the concentration, temperature and pressure relationships of quinine action on bacterial luminescence have indicated that the drug promotes a reversible denaturation of the protein catalyst concerned in light emission.[2] The effects of quinine on dehydrogenase activity in washed cells of *E. coli*, in relation to drug concentration, temperature and presence of bacterial extracts and coenzyme, have given no clear evidence of a protein-denaturing action of quinine on these systems except at relatively high temperatures.[3] Slight inhibitions of dehydrogenase activity, observed throughout the low temperature range, appeared to result from the formation of a loose complex between the drug and a coenzyme. Both types of effects, *i.e.*, in relation to protein and to coenzyme, are evidently involved in the action of quinine on growth rates and viability of bacteria, as indicated herein.

With *E. coli* as a test organism, growing in a glucose-asparagine "synthetic" medium,[4] the addition of quinine causes an immediate slowing of growth or a disinfection, depending on a narrow range of concentration added (Fig. 1). The bacteriostatic or disinfecting action ceases at once on dilution of the medium, and growth is resumed at approximately the rate of the control (Table 1).

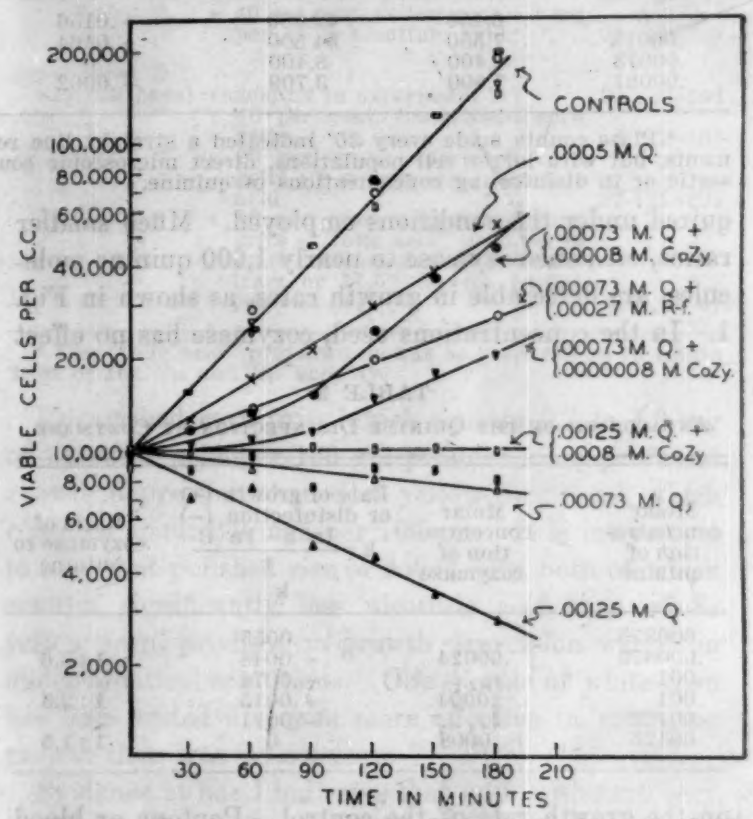


FIG. 1. Rate of growth of *E. coli* in "synthetic" medium at 37° C in relation to quinine (Q), cozymase (CoZy) and riboflavine (R.f.). Results of four experiments. Some of the curves have been extrapolated a short distance on the ordinate to coincide with 10,000 viable cells per cc at zero time in each case. No increase in rate of growth of controls without quinine was caused by these concentrations of cozymase and riboflavine, respectively.

Antagonism of the growth-inhibiting and the disinfecting effects may be brought about either by the addition of pure riboflavine or of partially pure cozymase[5] preparations. The latter are more potent and the amount needed depends upon the amount of quinine present (Table 2). To antagonize the disinfection, a ratio of roughly one molecule of coenzyme to between one and four molecules of quinine is re-

[1] This study is carried on with the aid of a grant from the Cinchona Products Institute, Inc.

[2] F. H. Johnson and L. Schneyer, *Amer. Jour. Trop. Med.*, 24: 163, 1944.

[3] The results of this investigation will be presented in a subsequent publication.

[4] The medium consisted of: 0.2 per cent. glucose, 0.2 per cent. asparagine, 0.47 per cent. $(NH_4)_2SO_4$, 0.5 per cent. NaCl, 0.27 per cent. $KH_2PO_4$, trace of $FeCl_2$, $CaCl_2$, and $MgCl_2$, plus NaOH to make pH equal to 7.15.

[5] Preparations of cozymase, about 50 per cent. pure, were kindly supplied by Dr. F. Schlenk. Although impurities may be concerned, the results shown in Fig. 1 and Table 2 are given with respect to the amount of cozymase added.

TABLE 1

REVERSIBILITY OF BACTERIOSTATIC AND DISINFECTING ACTION OF QUININE ON *E. coli*, BY DILUTION OF THE MEDIUM. TEMPERATURE 37° C.

| Growth period: | | | 0′–120′* | | | | 120′–240′* |
|---|---|---|---|---|---|---|---|
| Molar conc. of quinine | Viable cells per cc at 0′ (B) | Viable cells per cc at 120′ (b) | Rate of growth (+) or disinfection (−) $k=\frac{1n\ b-1n\ B}{t}$ k | Molar conc. of quinine after dilution with quinine-free or quinine-containing medium | Viable cells per cc at 120′ (B) | Viable cells per cc at 240′ (b) | $k=\frac{1n\ b-1n\ B}{t}$ k |
| 0 | 6,450 | 42,000 | +.0156 | 0 | 5,800 | 47,000 | +.0174 |
| .00013 | 7,550 | 54,500 | +.0164 | .00013 | 6,900 | 56,000 | +.0174 |
| .00073 | 8,400 | 8,400 | 0 | .00012 | 1,025 | 8,650 | +.0178 |
| .00081 | 7,800 | 3,700 | −.0062 | .00013 | 775 | 5,400 | +.0157 |

* Plate counts made every 30′ indicated a straight line relation between log of cell numbers and time. In similar experiments, but with larger cell populations, direct microscopic counts indicated no change of total cell numbers in fully bacteriostatic or in disinfecting concentrations of quinine.

quired under the conditions employed. Much smaller ratios, *viz.*, one cozymase to nearly 1,000 quinine molecules, are detectable in growth rates, as shown in Fig. 1. In the concentrations used, cozymase has no effect

TABLE 2

ANTAGONISM OF THE QUININE DISINFECTION BY COZYMASE

| Molar concentration of quinine | Molar concentration of cozymase | Rate of growth (+) or disinfection (−) $k=\frac{1n\ b-1n\ B}{t}$ k | Ratio of cozymase to quinine |
|---|---|---|---|
| .000875 | ..... | −.0055 | |
| .000875 | .00024 | +.0048 | 1:3.6 |
| .001 | ..... | −.0074 | |
| .001 | .0004 | +.0015 | 1:2.5 |
| .00125 | ..... | −.0071 | |
| .00125 | .0008 | 0 | 1:1.5 |

on the growth rate of the control. Peptone or blood serum, on the other hand, accelerate the growth rate of both control and quinine-containing cultures, and in this sense may be considered as antagonists of the drug's action. Unlike cozymase, however, peptone in concentrations as much as 1 mg per cc does not counteract the disinfecting action of high concentrations (0.00125 M.) of quinine. Although a precise interpretation requires extensive data, these results are consistent with the view that the effects of quinine on both growth and viability result in part from either a competition or a loose combination with cozymase. Loose combinations between quinine and substances not metabolized by the organism, including inhibitory substances, may also give rise to phenomena of antagonism.[2] A similar mechanism possibly accounts for antagonism of atabrine in bacterial growth by diverse agents.[6]

The effect of a given concentration of quinine on the rate of growth and on viability increases with rise in temperature (Table 3) in a manner resembling the evidently protein-denaturing action of this drug in bacterial luminescence. An apparently similar action is exerted by atabrine on the flavoprotein component of certain extracted and purified systems.[7] In the present instance, the rate of growth in controls rapidly decreases with rise of temperature above 39° C., and growth ceases at 45.2° C. During short exposures to 45.2° C, the number of viable cells remains constant, and growth is immediately resumed, at very close to the control rate, on cooling to 37° C. In the presence of quinine, similar reversible effects take place, but they occur at lower temperatures. These phenomena again resemble those observed with luminescence in relation to both temperature and quinine, as well as certain other drugs. Thus, the fundamental theoretical chemistry that has been extensively discussed in connection with the influence of temperature, pressure and drugs on luminescence[8] should be useful in furthering an understanding of the action of such factors on the systems controlling microbial growth rates and viability.

TABLE 3

RELATION OF THE GROWTH-INHIBITING AND DISINFECTING ACTION OF QUININE TO TEMPERATURE

| Temperature ° C. | Growth rate, k | | Per cent. inhibition |
|---|---|---|---|
| | Control | .00063 M.Q. | |
| 18.0 | .0021 | .0016 | 23.8 |
| 27.1 | .0068 | .0045 | 33.8 |
| 37.0 | .0169 | .0071 | 58.0 |
| 39.4 | .0172 | .0051 | 70.4 |
| 41.4 | .0132 | 0 | 100 |
| 45.2 | −.0023 | −.0115 | Disinfecting |

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## CORN AS AN ETIOLOGICAL FACTOR IN THE PRODUCTION OF A NICOTINIC ACID DEFICIENCY IN THE RAT[1,2]

THE consumption of corn has been associated with pellagra since the time of Casal in 1735. Handler,[3] working with dogs, has indicated that corn may be a causative agent in pellagra, and we[4] have found the nicotinic requirement of dogs to be markedly increased when corn grits are added to synthetic rations. With rats on rations containing corn, Frost and Elvehjem[5] found a very slight growth increase when nicotinic acid was fed, but they recognized that the rations used were deficient in other factors, thus complicating their results.

By using a synthetic ration containing sucrose 78, casein 15, corn oil 3, salts IV 4 and cystine 0.15 parts so prepared as to be essentially free of nicotinic acid (< 0.01 mgs per 100 gm) but adequate with respect to all other known fat and water-soluble vitamins except "folic acid" and p-aminobenzoic acid, we have produced a pronounced growth retardation in the rat by adding 40 per cent. yellow corn, white corn or corn grits at the expense of the entire ration. The addition of nicotinic acid at levels of from 0.5 to 1 mg per 100 gm of the corn-supplemented ration completely counteracts the growth-depressing action of corn. A specially prepared nicotinic acid-low norite eluate from solubilized liver extract fed at a level equivalent to 11.5γ of $B_c$ (*S. lactis* assay) per 100 gm of ration failed to counteract the deleterious effect of corn. These data are summarized in Table 1.

In addition we have found that the kind of carbohydrate and the level of casein modify the extent of the untoward effect of corn. With glucose as the carbohydrate or when the level of casein (nicotinic acid content < 0.005 mgs per 100 gm) was raised to 20 per cent. the growth depression caused by corn was diminished. In all cases, however, the addition of nicotinic acid resulted in growth stimulation.

TABLE 1

GROWTH-RETARDING EFFECT OF YELLOW CORN AND CORN GRITS AND THE COUNTERACTION WITH NICOTINIC ACID

| Rations used | | | Average weight gain in 4 weeks; 3 animals per group |
|---|---|---|---|
| *Experiment A* | | | grams/week |
| Sucrose basal | | | 30 (22–38) |
| " | " | + 1 mg per cent. nicotinic acid | 28 (21–33) |
| " | " | + 40 per cent. yellow corn | 13 ( 9–16) |
| " | " | + 40 per cent. yellow corn + 1 mg per cent. nicotinic acid | 33 (30–36) |
| *Experiment B* | | | |
| Sucrose basal | | (same as in experiment A) | 25 (20–29) |
| " | " | + 40 per cent. unenriched corn grits | 4 ( 2– 5) |
| " | " | + 40 per cent. unenriched corn grits + 1 mg per cent. nicotinic acid | 27 (21–29) |
| " | " | + 40 per cent. unenriched corn grits + "folic acid" prep.* ≅ to 1 per cent. solubilized liver extract or 11.5γ $B_c$ (*S. lactis*) per 100 gm | 5 ( 4– 6) |

* The "folic acid" preparation was so prepared as to retain most of the $B_{10}$ and $B_{11}$ activity.

Unenriched corn grits which contain 0.7 to 1.0 mg of nicotinic acid per 100 gm produce more profound growth depression than does yellow corn meal, which contains about 2.0 mgs per 100 gm. It is interesting to note that polished rice or rolled oats, both of which contain significantly less nicotinic acid than whole yellow corn, produce no growth depression when fed under identical conditions. One sample of white corn has been tested and was more effective in retarding growth than was yellow corn.

Evidence at hand indicates that milk, although very low in nicotinic acid (*ca.* 0.8 mg per cc), is active in counteracting the growth depression caused by corn.

Complete details of this work and the additional investigations which are in progress will be reported at an early date.

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# SCIENTIFIC APPARATUS AND LABORATORY METHODS

## METHODS FOR DETERMINING REFRACTIVE INDICES IN POLARIZED LIGHT MICROSCOPY

A SIMPLE but effective method for determining refractive indices in polarized light microscopy has been used successfully by students in these laboratories for the past three years. The main advantages of the method are that it is rapid and requires no extensive knowledge of geometrical or optical crystallography. It is of particular interest, therefore, to the chemist who has occasional need for microscopical observations under polarized light, but can not afford the time necessary to master the crystallography and physical optics required by the more extensive microscopical procedures.

[1] From the Department of Biochemistry, College of Agriculture, University of Wisconsin, Madison.

[2] Published with the approval of the director of the Wisconsin Agricultural Experiment Station. This work was supported in part by a grant from the National Dairy Council, Chicago, Illinois.

[3] P. Handler, *Proc. Soc. Exp. Biol. and Med.*, 52: 263, 1943.

[4] W. A. Krehl, L. J. Teply and C. A. Elvehjem. Unpublished work.

[5] D. V. Frost and C. A. Elvehjem, *Jour. Biol. Chem.*, 128: 23, 1939.

The determination of index of refraction for isotropic substances is carried out by the usual Becke line or half-shadow methods. In the case of anisotropic crystals, however, the customary order of procedure is reversed. A particle is first located which shows an interference figure under conoscopic observation, and from this the optical class and optic sign are determined. Next, refractive indices are determined on crystals showing the maximum flash of color during rotation between crossed nicols. By rotating such crystals to extinction and removing the analyzing prism, either the high index or low index will be shown. Further rotation of 90° to the second extinction position gives the remaining index. The indices so determined are identified from the previously determined optic sign.

If the crystals are uniaxial positive the lowest index found will closely approximate the value for omega; if the crystal is negative, the omega index will be very near the highest value found. In the case of biaxial crystals, the low value represents alpha and the high value approximates gamma. For biaxial positive crystals, beta will be nearer alpha than gamma, while in negative crystals it will be nearer gamma. The value for beta can usually be estimated with a fair degree of accuracy from these relationships. If desired, the value for beta can be checked on a crystal which shows an interference figure having the optic normal in the north-south position. A check on the omega index of uniaxial crystals can be made on crystals showing centered interference figures.

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## ARRANGEMENT FOR DRYING PROTEINS FROM THE FROZEN STATE

THE drying of proteins and similar products from the frozen state is now a daily requirement in many laboratories, and any arrangement which disposes of the chore efficiently can be used to good advantage.

For more than a year the apparatus sketched in Fig. 1 has been used effectively. One can dry any volume of material up to 200 cc, and have it in any appropriate container such as beaker, test-tube, centrifuge tube, Erlenmeyer flask, evaporating dish, ampoule and the like. As a result wasteful transfers of highly valuable materials can many times be avoided. The specifications for the apparatus can vary considerably and my description covers only one way of putting the general idea into operation.

Altogether there are three units. One of these (A) is a well-insulated sheet metal box 12×12×14 inches outside diameter. The box is provided with a lid, and is filled with dry ice to supply refrigeration. Through the box there is a built-in round channel about 3¼ inches in diameter. The walls of the latter are of sheet metal similar to the metal walls of the refrigerator box itself.

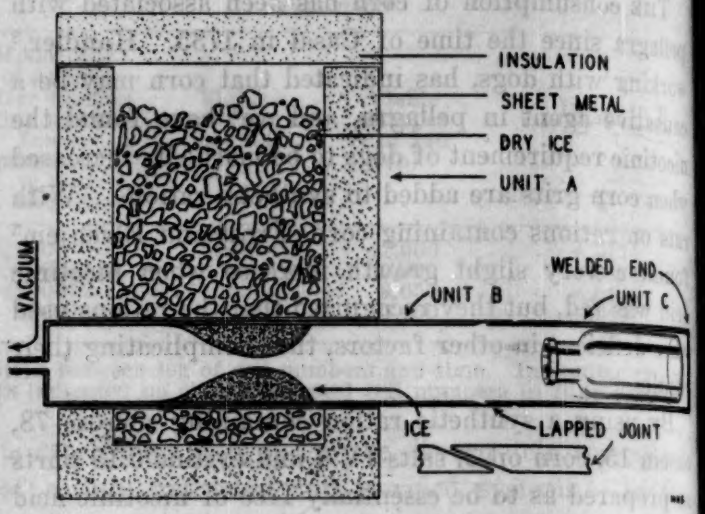


FIG. 1. Cross section of apparatus drawn to scale.

Units B and C are made from the same stock of 3-inch malleable black iron pipe or brass tubing, and are connected by a lapped joint. This joint must be machined accurately, lapped carefully and handled as one would a ground glass joint or the ground glass surfaces on desiccators. When unit B is in the round box channel it is cold and becomes a condenser, and unit C, which is warm, contains the material to be dried. During the short time required for establishing a vacuum unit C must be cold. That detail can be handled either by precooling or by pushing both B and C to the left until C is in the cold channel of the box. During the drying operation it is well to direct a fan at unit C.

If 100 cc of water are shell frozen in a large centrifuge bottle it is best to pack the box full of dry ice and conduct the run as an overnight operation. That practice can be recommended for most of the average work.

With the use of ordinary ingenuity the apparatus can be handled and modified to achieve special objectives. For instance, heat can be applied to C for the purpose of removing the last traces of moisture toward the end of a drying operation. For that purpose there are suitable heating devices available. Or one may wish to seal material under vacuum. To do that holes are drilled in unit C, suitable taps are provided for the purpose of permitting rubber connections to ampoules, etc. Another degree of freedom can be exploited by completely setting aside unit C and substituting a balloon flask. Connections are then made with the use of a rubber stopper. The flask is roughly covered with wire screen for protection against possible breakage.

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